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# POWER

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# Shows and Expositions

THE industrial progress of the world has been marked by some notable expositions and series of expositions.

In many cities and sections industrial and mechanical expositions are held, some regularly and some sporadically.

In the larger cities there has been of late years a tendency to specialize, and instead of the "Mechanics Fair" there are the Power Show, the Textile Exhibit, the Electrical Exposition, the Chemical Show, the Automobile Show, the Boat Show, not to mention those not related to mechanics.

Properly conducted, these shows have a real stimulating influence and educational value. Many a person has got his first conception of how things are made, has learned of new and, to him, useful apparatus and processes; many producers have been incited by the competitive features of the exhibit to greater effort and accomplishment.

The multiplicity of these exhibits, swelled by those held in connection with the conventions and meetings of trade and engineering organizations, is a source of embarrassment to those whose exhibits are depended upon to give the show its attractiveness.

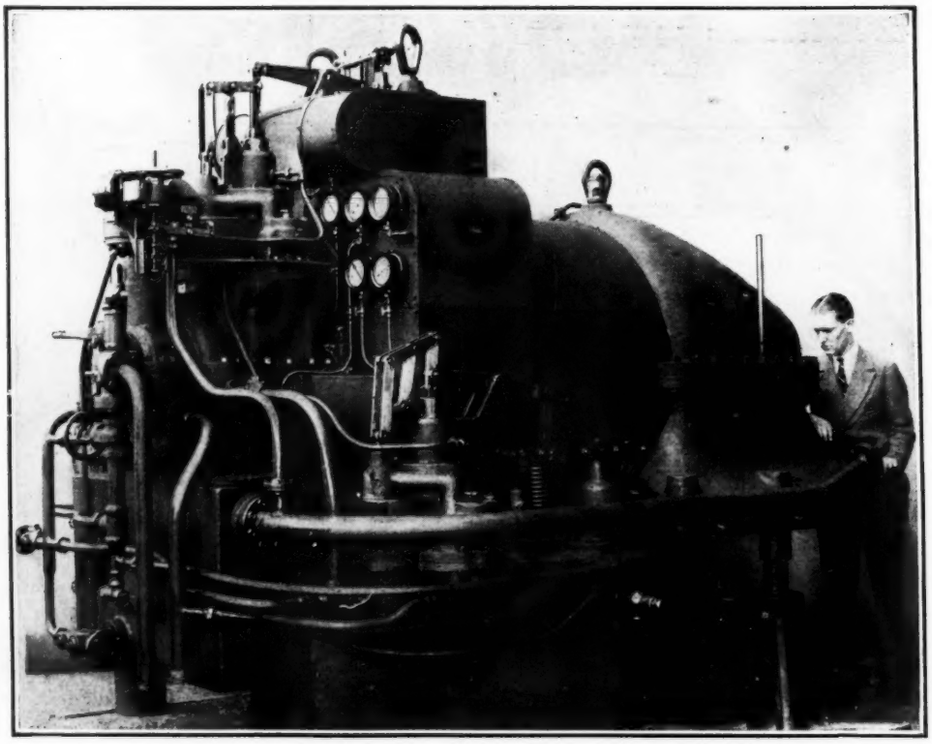
To accept anything like all the opportunities that are offered for such participation would entail an expenditure of time and money that few concerns would feel to be justified.

Any concern, however small, can "afford" to take part in any number of such exhibitions so long as it gets enough out of each in contacts, publicity and immediate or eventual orders to cover the expense.

But many who feel that they or their business would not suffer if certain shows were not held at all, hesitate to stay away for fear that their absence will place them at a disadvantage with respect to competitors who may be represented.

After all, it is the exhibitors who make these shows possible and determine their character. Co-operation among themselves and with the managers of shows that have established their usefulness and of those that are proposed, should produce the best results in the long run for the promoters of the shows, the exhibitors and the public.

F. R. Low



# Governing Bleeder Turbines *at the* Lincoln Oil Company

By E. G. Allen
Westinghouse Electric & Manufacturing Company

**The control for this turbine must act to satisfy the demand for process steam, electric energy, and at the same time use the maximum amount of return low-pressure steam**

"USING the Same Steam Three Times" was the caption of an article that appeared in the May 17, 1927, issue of *Power*, describing a bleeder turbine installation at the plant of the Lincoln Oil Company, Robinson, Illinois. It will be remembered that this is a case of a plant extension involving the installation of new boilers, and that the two turbines are arranged to take steam at 250 lb. gage and to bleed to the process and to the plant auxiliaries at 125 lb. pressure (the original boiler pressure). They are further arranged to take low-pressure steam, returned from the process at 2 lb. gage, and expand it to 28 in. vacuum, thus serving in the double capacity of "reducing valve" and low-pressure turbines.

In designing the control gear for these units, there were of course three demands to be satisfied. The process and the plant auxiliaries must be supplied with steam, the maximum usable amount of low-pressure steam must be returned to the turbine and the electrical demand must be satisfied. In addition, it was highly important that fresh water be conserved.

In correlating and evaluating these three functions, the bleeder demand naturally takes first place, since the process work is dependent on this source. Electrical load must come second and conservation of the residual energy in the low-pressure steam, third. Lastly, provision must be made to return all the steam or condensate to the feed system. With this in mind the control arrangement was developed.

Two governor mechanisms are provided, one to control the admission of high-pressure steam to the steam chest and one to control the admission of low-pressure returns and high-pressure bypass steam to the reaction portion of the turbine. The impulse and reaction stages are separated by a diaphragm as shown in Fig. 1. This figure is the same as Fig. 4 in the article of May 17, except that the manually operated bypass valve marked *A* in the latter, is omitted. Such a hand valve was contemplated, but discarded in favor of the governor-controlled bypass.

The actuating force for both governors is the centrifugal force of a column of oil in an impeller mounted on

the end of the turbine shaft. This force acts on a relay sleeve against the resistance of a coil spring. The relay sleeve slides within a hollow operating piston rod, and the sleeve and hollow rod are ported so that motion of the sleeve relative to the rod admits oil to, or releases it from, the operating cylinder, causing motion of the operating piston and, by means of the linkage shown, the closing or opening of the steam valves.

With this type of governor it is obvious that if a back pressure be applied to the end of the relay sleeve not acted upon by the impeller oil discharge, the turbine speed may be altered by varying the oil back pressure on the relay sleeve. This feature has been employed in the system of control to be described.

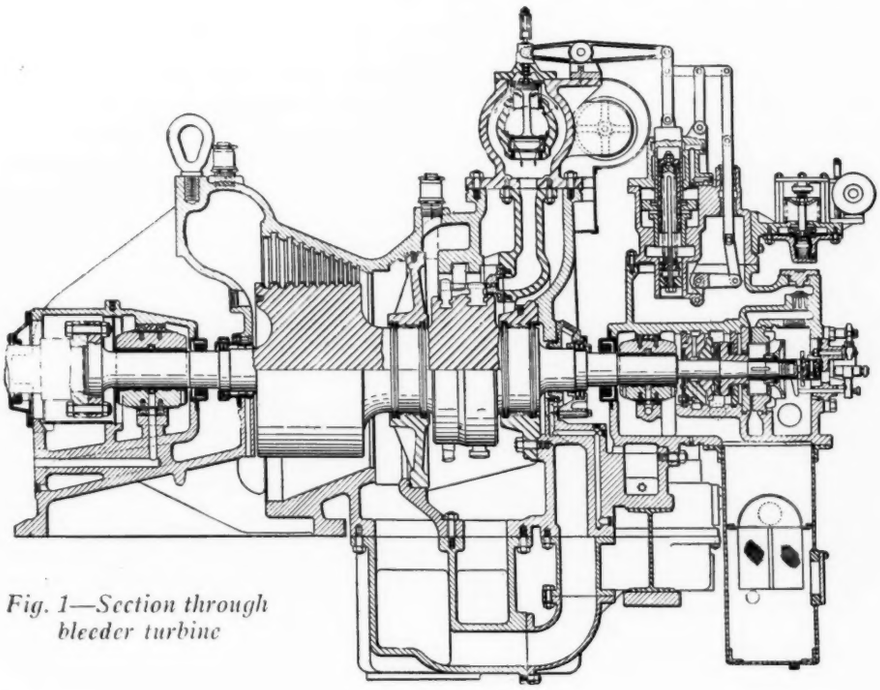
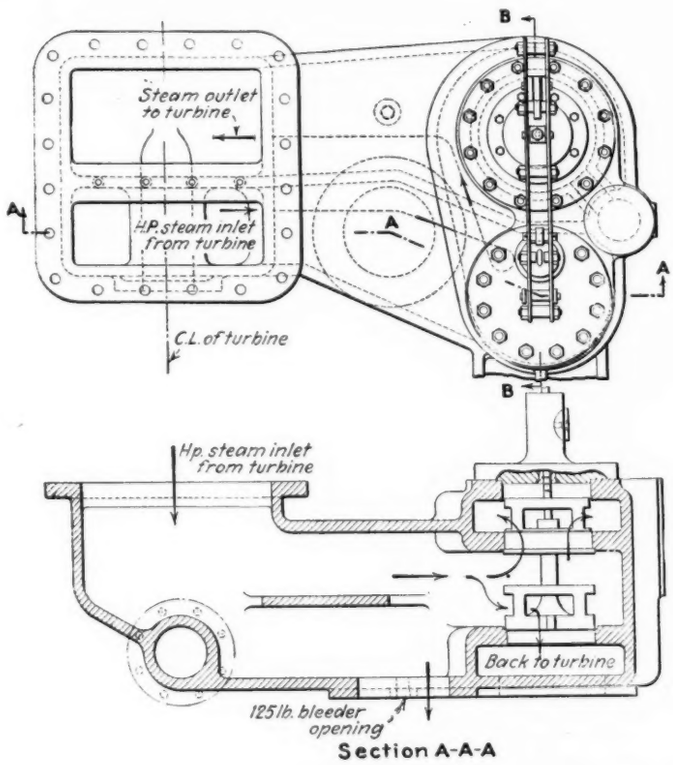


*Fig. 1—Section through bleeder turbine*

The high-pressure governor and linkage are clearly shown in Fig. 1. Fig. 2 shows a section through the low-pressure steam chest, while Fig. 3 shows the bleeder and induction control mechanism.

Referring to Fig. 3, *A* is a small piston subjected to the bleeder steam pressure and sealed against leakage to atmosphere by a flexible diaphragm. It carries on knife edges a lever *L* fulcrumed at *B* and weight loaded at *C*, a dashpot being provided to steady the action. At the end remote from *C* this lever is connected to another, which acts upon two spring-loaded regulating valves *E* and *F*, the fulcrum being located between the two valves. Valve *E* controls the oil back pressure on the main speed control governor relay, and valve *F* controls the back pressure on the bypass-and-induction governor.

If, with constant electrical load, the bleeder pressure falls, the weights *C* will pull down the lever *L*, thus, in turn, tilting lever *D* toward the right. The compression of the springs on valve *E* will be increased and that of the spring on *F* reduced. It follows, therefore, that the back pressure on the low-pressure gov-



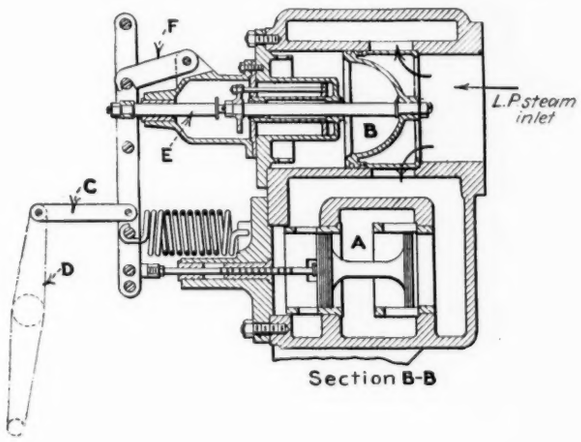




*Fig. 2—Section through low-pressure steam chest*

ernor relay will be reduced, causing it to move toward the closing position, while the pressure on the main governor relay will be increased, causing it to move toward the opening position. In this manner more steam will be admitted to the turbine, to satisfy the bleeder demand, while the low-pressure induction will be reduced a corresponding amount to maintain constant electrical load without change of speed.

The manner in which this is accomplished may be understood by reference to Fig. 2. The double piston valve *A* controls the bypassing of steam from the impulse chamber to the reaction blading. The valve *B* is a constant-pressure valve, opened only by an increase of pressure in the low-pressure return line, but capable of being closed or throttled by the low-pressure governor.

Both valves are operated by a common lever connected by link *C* and lever *D* to the low-pressure governor. A coil spring holds the bypass valve closed until steam. The action of the two governors is practically simultaneous and the relative quantities of inlet and bypass steam necessary to maintain the balance are automatically and instantaneously adjusted by the control mechanism.

Naturally, since not all the plant operations are synchronized, there may be times when the supply of low-pressure returns is large while the electrical load is small and the bleeder demand fairly large. At such times there will be an excess of low-pressure returns and the low-pressure induction valve will be held closed or partly closed by the low-pressure governor. Under these circumstances some other outlet must be provided for the low-pressure returns. To meet this condition, another constant-pressure valve is provided, connected to the condenser and set to operate at about one pound above the low-pressure induction valve. In the situation described, this valve will open and pass the excess

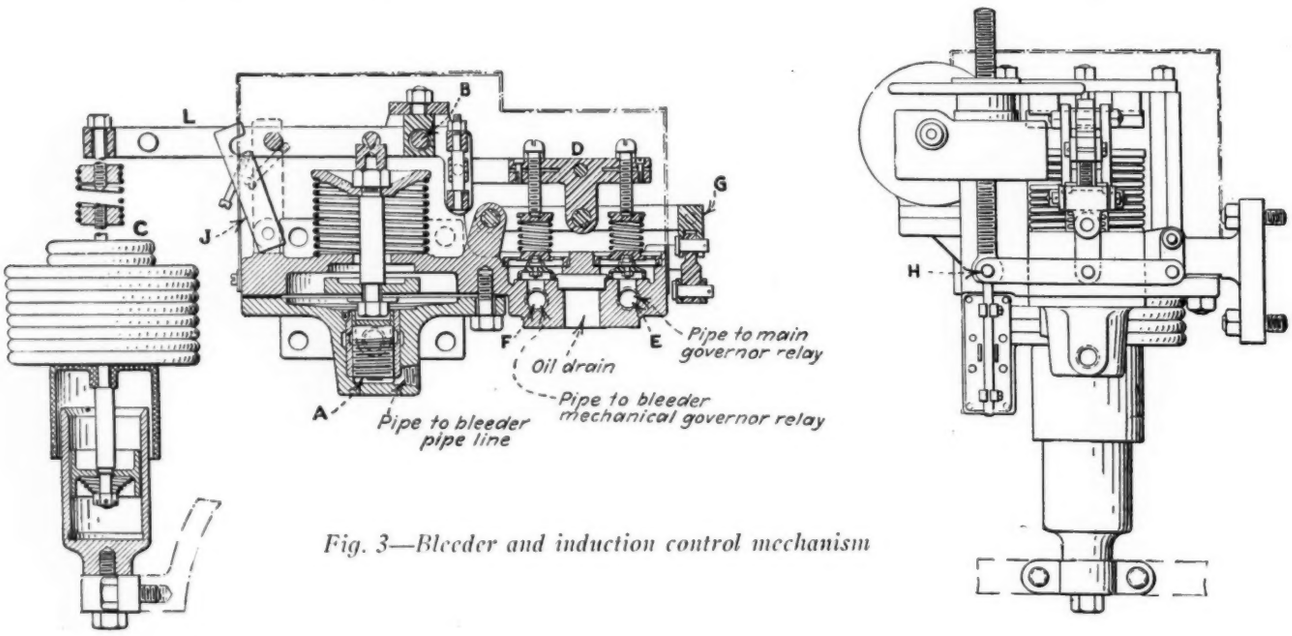



*Fig. 3—Bleeder and induction control mechanism*

the induction valve is fully open. Latch *F* is used to lock the low-pressure induction valve closed if the unit is to be run straight condensing. Normally, it is thrown back in the off position.

In view of the location of the coil spring and the relative lever lengths, it will be seen that the bypass valve cannot begin to open until the induction valve closing plunger *E* is in its uppermost position. This means that an increase in electrical load, with constant bleeder demand, will be satisfied by increasing the low-pressure induction up to the point where the supply of low-pressure returns is insufficient to carry the difference between the total load and that developed by the steam in the high-pressure element. Then additional movement of the low-pressure governor will cause lifting of the bypass valve against the resistance of the coil spring, with the induction valve closing plunger as a fulcrum, and sufficient steam will be bypassed to satisfy the electrical load. At the same time the reduction in flow of bled steam to the 125-lb. line, owing to the bypassing, will bring about a reduction in pressure which will cause the regulator to drop and admit additional high-pressure returns to the condenser, thus conserving the fresh water supply.

Referring again to Fig. 3, it will be seen that, by means of the linkage indicated at *G* and *H*, the fulcrum point of lever *D* may be raised or lowered with the aid of a threaded spindle operated by motor or by handwheel, as desired. Change of position of the fulcrum causes a change in the pressure on the regulating valves *E* and *F*, and this device, therefore, constitutes a speed changer.

If the unit is to be operated straight condensing, the latch *J* is hooked onto lever *L*, thus securing the latter against movement. The similar latch previously mentioned in connection with the low-pressure governor, is likewise hooked in place, and the turbine is then controlled by the main governor only, and the speed may be adjusted by means of the speed changer that has just been described.

Turbine controls of this character should find many applications in industrial plants, where process and heating steam are required, its use resulting in substantial gains in economy.

# Powdered Coal for Small Boilers in Industrial Plants

IN A paper read before the first national meeting of the A.S.M.E. Fuels Division in St. Louis, Mo., a short time ago Henry Kreisinger, Research Engineer, Combustion Engineering Corporation, gave some interesting results obtained in the application of powdered fuel to small industrial boilers.

According to this paper the power-plant operator can generally appreciably improve his operating efficiency by using pulverized coal firing.

However, he cannot obtain the high efficiency and the greater capacity that are obtained with the large installation. The size of his plant does not justify him in putting in the best combination of equipment such as is used in the large central stations. The cost would be prohibitive. The small plant operator can buy only such equipment the cost of which will be justified by the size of the plant and the saving in coal that can reasonably be expected.

The small plant is usually a part of a manufacturing establishment, and its financing is done on a different basis as to the rate of return on the investment from that which is the case with large plants and public utility companies. The calculations on the cost and possible

TABLE I

| | |
|---|---|
| Installation | A. H. Budlong, Nursery, Chicago, Ill. |
| Object of plant | Heating glass houses for cultivation of flowers and pumping water for irrigation purposes. |
| When installed | 1925. |
| Number and size of boilers | Two horizontal return-tubular boilers, 72 in. in diameter, 18 ft. long and containing 1,830 sq.ft. of heating surface each. |
| Number and size of tubes | 124 3-in. tubes. |
| Kind of setting | Brick, partly air-cooled side wall and bottom of furnace. |
| Method of firing | Direct firing pulverized coal. |
| Width of furnace | 7 ft. |
| Height of furnace | Bottom of shell to bottom of furnace, 7 ft. 10½ in. rear, 8 ft. 0 in. front. |
| Length of furnace | 23 ft. |
| Kind of pulverizing mill | Two Raymond No. 3 impact mills. |
| Capacity of each mill | 1,400 lb. |
| Method of driving mills | Steam turbine direct connected, 1,800 r.p.m. |
| How started when boilers are cold | Cold furnace can be started with ball of oily waste on a rod. However, 20 lb. of steam is required to start turbine, so if both boilers are cold, one must be started with wood fire to raise 20 lb. of steam to run turbine. |
| Number and type of burners | One 8-in. Leach burner per boiler, horizontal firing. |
| Load on boilers | Maximum winter load 12,000 lb. of steam per hour. Minimum load during warm weather, 2,400 lb. of steam per hour intermittently. |
| Continuity of operation | Boilers on for three months at a time. |
| Approximate efficiency | 78 to 80 per cent at 150 per cent of rating. |
| Coal used | Illinois No. 5 size. |
| Is installation satisfactory? | Yes, very. |

returns with the industrial plants must show frequently nearly double the rate of the public utilities' return before financial backing can be obtained. As the result of this different basis of financing, many of the industrial plants must go without economizers and air heaters. Even the heating surface of the boilers may have to be reduced. Thus the products of combustion are allowed to escape at comparatively high temperatures, making it impossible to obtain high efficiency.

In the effort to keep the first cost down, the furnaces of the small plant must forego the advantages that can be derived from air- or water-cooled walls and bottoms. The furnaces may have to be built with solid brick walls and flat bottoms, which construction makes it necessary that they be operated with excess air in order to avoid erosion of the walls and make ash removal possible without shutting down the boiler. Such operation, of course, results in lower efficiency.

The small industrial plant may be operated only during the daytime and remain banked a large part of the night.

TABLE II

| | |
|---|---|
| Installation | Pejepscot Paper Co., Lisbon Falls, Me. |
| Object of plant | Steam for power and process. |
| When installed | 1924. |
| Boilers | Two Stirling; 3,750 sq.ft. of heating surface each; brick furnace with air-cooled hollow walls and water screen over the furnace bottom. |
| Furnaces | 2,170 cu.ft. of furnace volume; vertically fired; storage system. |
| Mills | One Raymond 6-roll, 6 tons per hour capacity. No driers used; coal dried in mill using hot flue gas. |
| Burners | Two Lopulco burners to each boiler. |
| Rating | 14,000 to 28,000 lb. steam per boiler per hour. |
| Service | Operates 24 hours, 6 days a week. Plant idle on Sundays. |
| Efficiency | 80 to 81 per cent. |
| Coal used | New River. |

If the fires in a banked boiler are started at six in the morning, it may be one or two o'clock in the afternoon before the setting becomes heated and all the heat generated in the furnace becomes available for making steam, instead of being partly absorbed by the setting. Heat absorbed by the setting during the first part of the day is largely lost after the boiler goes on bank in the evening. The average efficiency for the day's run may be 2 or 3 per cent lower than it is during the afternoon after the setting becomes thoroughly heated.

## Some Typical Installations

The accompanying tables give details on five typical installations for powdered coal firing of small steam boilers in industrial plants:

Table I gives information on an installation of powdered coal under a horizontal return-tubular boiler having 1,830 sq.ft. of heating surface. This is one of two similar fired boilers at the nursery of A. H. Budlong, Chicago, Ill. The boiler supplies steam for heating the glass houses and for pumping water for irrigation purposes. The heating season is ten months long. Steam is also used on cold nights during the remaining two months.

Coal is pulverized by a Raymond impact mill, driven by a steam turbine. The pulverized coal is discharged directly into the furnace and burned by means of a Leach burner. The operating rate of the combustion varies from 235 to 1,100 lb. of coal per hour. The exhaust steam from the turbine driving the mill is used in the heating system.

The boilers are kept in service about three months at a time before they are taken off the line for general cleaning inside and out. The plant has been designed for continuous operation. Mill repairs during the heating season consist only in changing the hammers. A set of hammers has been changed in eleven minutes from the time the turbine has been shut down to starting it up again. Major replacements are made in the summer.

The operation of this installation has been satisfactory. The content of $CO_2$ in the flue gases varies from 12 to 16 per cent and depends on the rate of working. With the high rates of working and high percentage of $CO_2$,

there is a tendency for the ash to fuse, which would be expected with Illinois coal and the type of furnace used.

Table II gives information on an application of powdered coal to two small Stirling boilers at the plant of the Pejepscot Paper Co., Lisbon Falls, Me. The two boilers are set in a battery with air-cooled furnace walls and bottoms. A storage system is used at this plant. The plant operates continuously six days a week and is shut down over Sunday.

Table III shows a powdered coal application to one of the three Edge Moor water-cooled boilers at the plant

TABLE III

| | |
|---|---|
| Installation | Cushnoc Paper Company, Augusta, Me. |
| Object of plant | Steam for power and process. |
| When installed | 1926. |
| Boilers | Three Edge Moor horizontal water-tube boilers, 6,000 sq.ft. of heating surface each. |
| Furnaces | One furnace has water-cooled fin-tube side walls, and a radiant superheater in the rear wall. The other two have air-cooled hollow walls with radiant superheater in the rear wall; furnace volume, 2,800 cu.ft.; all three furnaces are direct-fired. |
| Mills | One No. 50 Raymond impact mill to each boiler; capacity, 4,500 lb. of coal per hour; motor driven. |
| Burners | One Couch burner firing horizontally to each boiler. |
| Load | 30,000 to 36,000 lb. of steam per hour per boiler. |
| Service condition | 24 hours per day for 6 days a week; plant shut down Sundays. |
| Efficiency | 78 per cent. |
| Coal used | Pocahontas slack. |

TABLE IV

| | |
|---|---|
| Installation | Atlas Portland Cement Co., Northampton, Pa. |
| Object of plant | Steam for power for manufacturing cement. |
| When installed | 1926. |
| Type of boiler | One 2-drum Ladd boiler; boiler heating surface 7,200 sq.ft. |
| Type of furnace | Water-cooled fin-tube side walls and roof. Water-cooled tubes and refractory front wall; water screen over bottom of furnace; water-cooled furnace surface, 2,150 sq.ft. |
| Air heater | 24,480 sq.ft. heating surface. |
| Width of furnace | 24 ft. 6 in. |
| Length of furnace | Front to rear, 20 ft. |
| Height of furnace | Roof to water screen, 20 ft. |
| Method of firing | Direct firing, vertically downward. |
| Number and type of burners | Eight Lopulco burners. |
| Kind of pulverizing mills | Two No. 70 Raymond impact mills. |
| Load on boiler | 60,000 to 140,000 lb. of steam per hour. |
| Coal used | Pennsylvania high-volatile bituminous coal. |
| Approximate efficiency | 81 per cent operating efficiency by the month. |

TABLE V

| | |
|---|---|
| Installation | American Writing Paper Co., Holyoke, Mass. |
| Object of plant | Steam for power and process. |
| When installed | 1926. |
| Boilers | Two B. & W. horizontally fired water-tube boilers, 4,000 sq.ft. of heating surface each. |
| Furnaces | Solid brick-wall furnace; volume, 1,386 cu.ft.; direct fired; horizontal burners. |
| Mills | Two No. 40 Raymond impact mills, one to each boiler; capacity of each mill, 2,500 lb. per hour. |
| Burner | One Couch burner to each boiler. |
| Load | 24,000 lb. steam per hour. |
| Efficiency | 76 per cent. |
| Coal used | Pocahontas. |

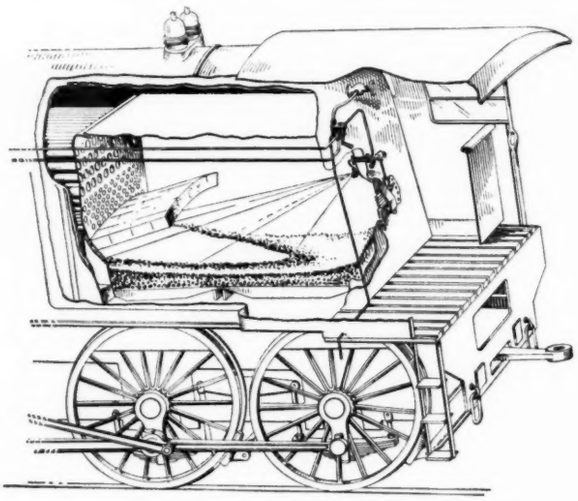
of the Cushnoc Paper Co., Augusta, Me. At this plant the boilers are fired by the direct-firing pulverized-coal system. They are fired horizontally with one couch burner to each boiler. One of the furnaces has fin-tube, water-cooled side walls, whereas the other two have air-cooled hollow walls. All three furnaces have air-cooled furnace bottoms and radiant superheaters in the rear wall.

Table IV shows a two-drum Ladd boiler equipped with air heater and water-cooled fin-tube furnace at the plant of the Atlas Portland Cement Co., Northampton, Pa. This is fired with powdered coal by the direct firing system, using vertical firing and Lopulco burners. The boiler is kept continuously in service for a month. It is then taken off the line and thoroughly washed inside on account of bad feedwater.

Table V gives information on a powdered coal application to two B. & W. horizontal water-tube boilers. This installation uses the direct firing system. The coal is fired horizontally with a couch burner.

## Pyramid Steam Jet to Reduce Smoke

THE well-known Continental Correspondent of the *Chicago Daily News,* A. R. Decker, calls attention to an arrangement of steam jets for smoke prevention, devised by the late Theodore Langer, Austrian inventor



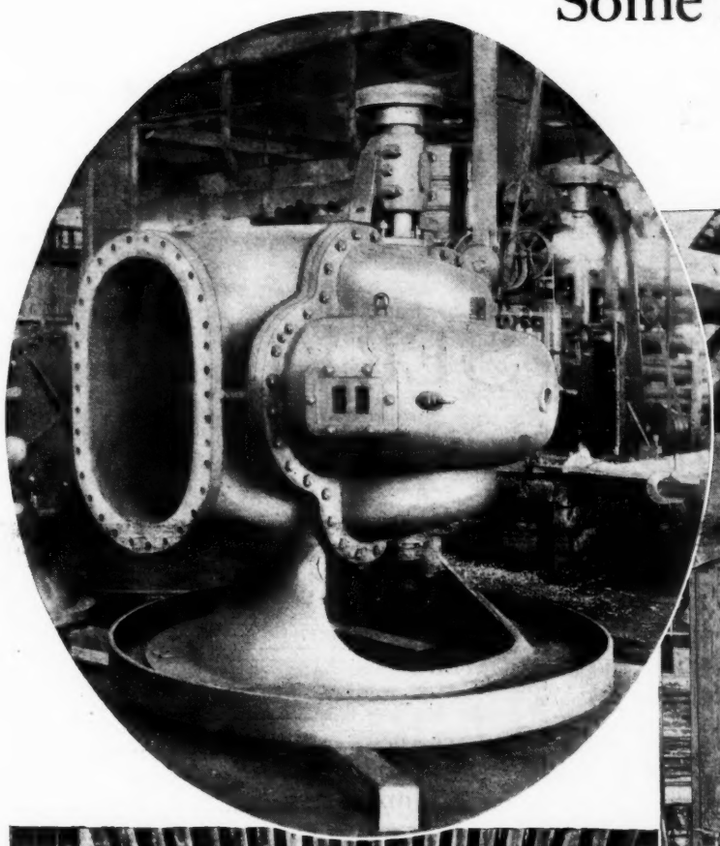
*The steam pyramid applied to a locomotive*

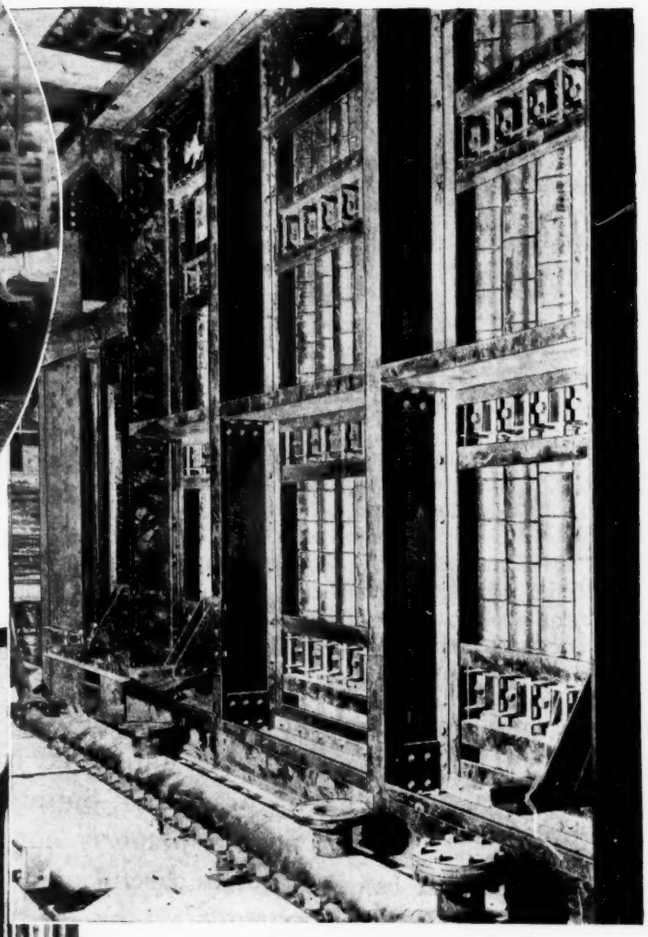
and authority on smoke elimination. This particular arrangement is known as the "Pyramid Steam Jet" and was devised to eliminate smoke and cinders on railway locomotives. Its success in that field has led it to be adopted on boilers of many industrial power plants, especially in sections where there is strict enforcement of smoke ordinances.

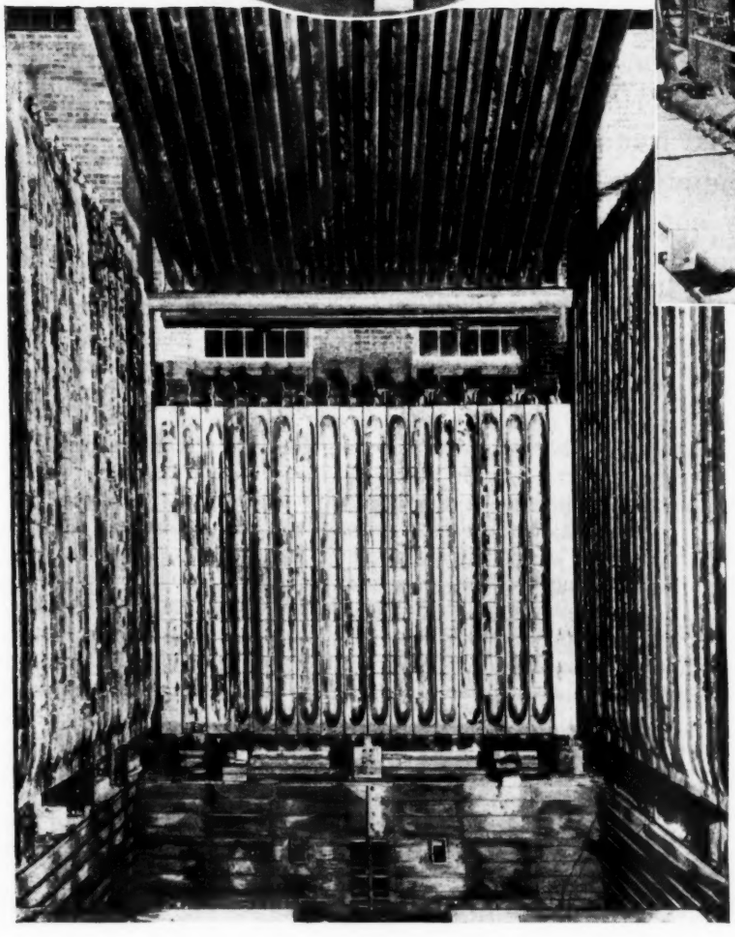
The principle of the steam pyramid, which is shown in the illustration, is that the smoke gases are stopped from going through the boiler tubes by the base of the steam pyramid and are forced back over the fire grate and under the pyramid, where a complete combustion of smoke and fire particles is obtained before allowing the gases to escape. One of the principal functions of the steam pyramid is that no cold air is allowed to reach the boiler tubes when the firebox door is opened. Cold air entering the firebox is forced over the grate and under the steam pyramid before it can reach the boiler tubes.

TEST RESULTS GIVEN by Prof. R. J. Roark in the *Journal* of the American Welding Society show the average ratio of impact strength of a welded specimen to the impact strength of a riveted specimen of the same static strength to be 1.37. The average energy of rupture is given as 6,014 in.-lb. per sq.in. of weld.

# Some Modern Power-Plant Equipment







Photos by courtesy of the Foster-Wheeler Corporation.

*Oval — Vertical 23,500-gallon circulating pump installed in the Welectka power station of the Public Service Corporation, Oklahoma.*

*Above—Support and framework details for one of the furnace side walls for one of the boilers in the Price Brothers and Company, Ltd., paper mill, Riverbend, Quebec. The outside of the water wall can be seen in the panels.*

*Left—Inside of the furnace showing the water walls previously mentioned. Photograph taken before the brickwork had been started. These furnaces are for pulverized coal firing.*

# *Supplying* POWER SERVICES *for a* Great Variety of Products

By Graham L. Montgomery
*Editorial Staff, Power*

**Basing their operations upon the fundamental metal-working processes used in manufacturing firearms and ammunition, the Winchester Repeating Arms Company has, since the close of the World War, extended its activities until today it turns out a great variety of products. Supplying power services for such a plant is not a simple problem but requires careful planning and execution. The system used by the Winchester Company is, however. proving more satisfactory each year.**

THE more diversified the products of a plant are, the more complicated is the problem of supplying that plant with power services in an economical manner. All Power Services are based, in the last analysis, upon heat. When there is only one product to consider, naturally the total heat consumed, whether it be as direct heat, electric power, compressed air, or whatnot, is all chargeable to that product. The measure of economy then becomes evident, and it is a simple matter to determine from year to year, from month to month, or from day to day, how much the share of power services in the cost of production is and how much this share varies.

But where a great many different products must be dealt with, into each of which power services enter in a different way, the bookkeeping cost of such a method as the foregoing for determining relative economy becomes prohibitive. Obviously, some shorter and cheaper method must be found for controlling the supply of power services so that the desired results are obtained.

One method of attacking this problem is found at the Winchester Repeating Arms Company, New Haven, Conn. This company, whose plant covers 85 acres with multi-story buildings, found itself, after the World War, with a greatly increased capacity—more than required for its firearms and ammunition business.

It immediately began to branch out into the manufacture of other products. This practice has been continued, until at the present time the list of products made is very great. Included in this line are sporting goods such as rifles, shotguns, paper shot shells, metallic cartridges, shot, fishing rods (steel and bamboo), reels, tackle; skates; tools, pocket knives and flat cutlery; scissors and shears; radiators; flashlights; flashlight and radio batteries; and automatic refrigerators and household electric washing machines.

While this diversity is great, still there are points in common which make all these varied products logical members of a single group. In making guns and ammunition the basic processes are metal working, starting with steel, copper, brass or some other metal, and then casting, rolling, forging, drawing, punching, pressing, machining or otherwise processing it. With the other products now made at this plant, the same is true, in that the basic processes for all the products are the same.

The power services used in carrying out these manufacturing processes are steam, electricity, compressed air, fuel gas and refrigeration. Steam is generating in sixteen boilers—twelve B. & W. boilers of 2,500 sq.ft. of heating surface each and four Bigelow-Hornsby boilers of 7,500 sq.ft. of heating surface each. Two of the B. & W. boilers are equipped with Coxe stokers, and the other B. & W. boilers use Riley stokers. The Bigelow-Hornsby boilers have Westinghouse stokers. Six of the

B. & W. boilers and the Bigelow-Hornsby boilers are directly used for power steam, the other B. & W. boilers being used for process steam. Additional process steam is obtained from the extraction turbines.

Power steam is generated at 175 lb. gage and process steam at 100 lb. gage. The boilers operate at an average of 200 per cent of rating. The average evaporation for the year, including banked fires, is 8.7 lb. of water per pound of coal as fired. Feed water enters the boilers at an average of 273 deg. F. All condensate is returned to a sump, whence it is pumped through the heaters and economizers to the boilers. Condenser cooling water is used in part for feed makeup, the remainder going through a cooling tower and thence back to the condensers. That part used for makeup is treated in a Permutit softener and is then pumped into the sump where the condensate is received.

All the electric power used is generated at the plant, both alternating and direct current. The rated direct current capacity is 1,700 kw. This is obtained from two turbine-generators and a 500 kw. motor-generator set. The turbine-generators are 600-kw. De Laval machines driving 500-kw. Crocker-Wheeler generators through reduction gears.

The alternating current is generated by five 1,000-kw. Westinghouse turbine-generators. Three of these are of extraction type and the other two are mixed-flow machines. Current is generated at 2,300 volts, being stepped down to 440 volts in five substations, located conveniently about the plant.

The air compressors have a total capacity of 7,500 ft. There are two Ingersoll-Rand machines of 1,500 ft. capacity each, one Mesta machine of 3,000 ft. capacity, and one Laidlaw-Dunn-Gordon compressor of 1,500 ft. rating, all of the reciprocating type. Air from these passes through an aftercooler before going to the air mains, which serve every department of the plant.

Refrigeration is supplied by two 15-ton Frick plants. These are convenient to the points of use, in two different parts of the plant.

A large quantity of gas is used at this plant in the firing of various types of furnaces, and all this gas is made in the plant. The equipment consists of seven Loomis-Pettibone gas generating sets, each capable of producing 50,000 cu.ft. of water gas and 150,000 cu.ft. of producer gas per hour. All the sets are equipped with waste-heat boilers, which supply steam for the manufacture of water gas during that part of the generating cycle.

Steam is used for power generation, gas making, process work and building heating. Among the processes requiring steam are drying, heating, washing equipment, heating waterproofing for paper shells, operating steam hammers and presses, and atomizing oil for the rolling mills. Building heating is done with exhaust steam, the majority of this work being with hot-water systems in which the water is heated indirectly by the steam, so that the condensate can be returned without contamination to the boiler feed.

As an example of the quantities used, in January, 1928, 155,242,000 lb. of steam was produced. Of this total 120,542,000 lb. was used in process work. Power equipment required 31,700,000 lb. of steam, while 3,000,000 lb. of steam was required by the gas plant.

All the electric power used is generated at the plant, there being no connection, even, with any outside source of current. In 1927 the total generated was 12,500,000 kilowatt-hours.

Direct current is generated for use in elevators, magnetic chucks and motors. Alternating current is used in motors throughout the shop, in the printing plant, and for such process work as heating lead baths and making batteries.

In January, 1928, alternating current to the total of 1,200,000 kw.-hr. was generated. Direct current totaling 350,000 kw.-hr. was generated in this same month, of which 120,000 kw.-hr. was generated from 150,000 kw.-hr. of alternating current, and the remainder was directly generated from steam.

Compressed air is used for automatic machinery in the battery department, for blowing chips from the dies in the forge department, for wood-working machinery,

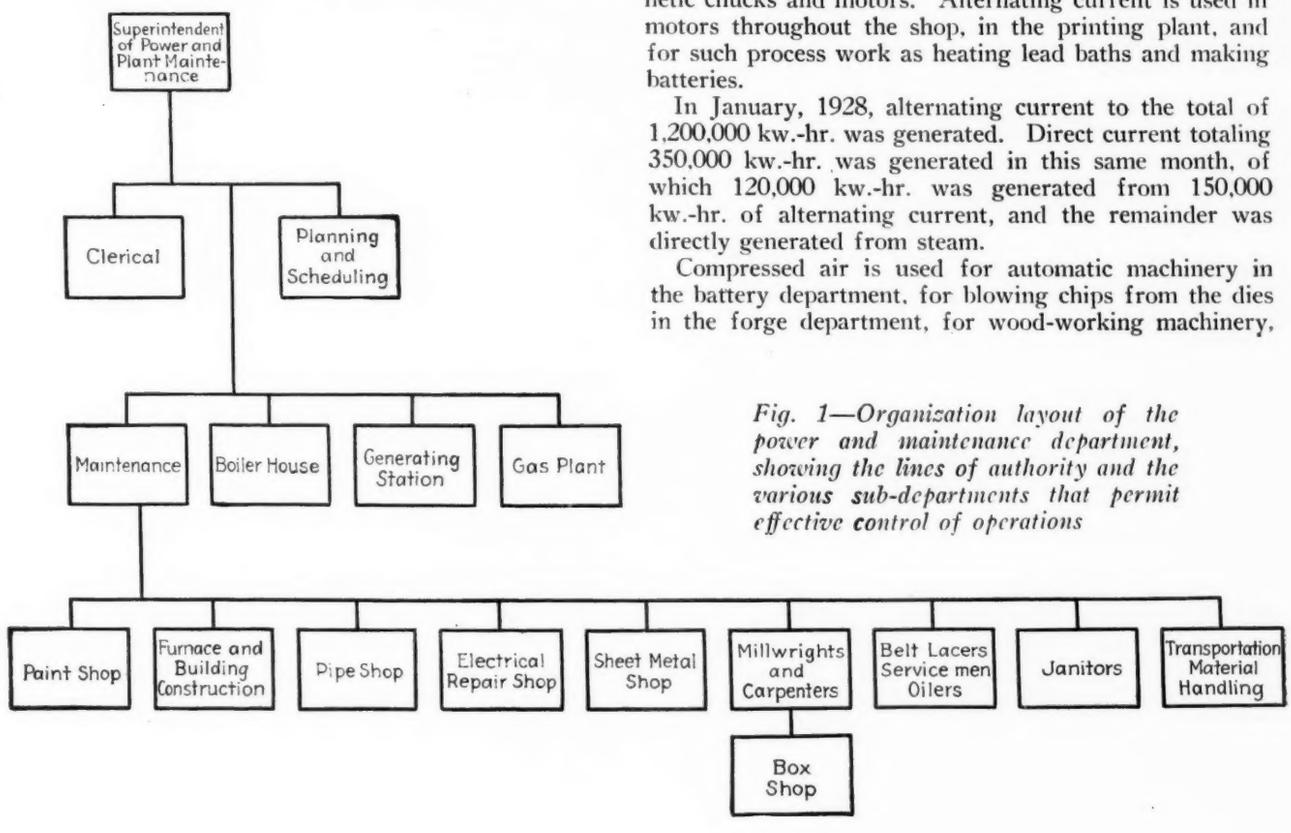



*Fig. 1—Organization layout of the power and maintenance department, showing the lines of authority and the various sub-departments that permit effective control of operations*

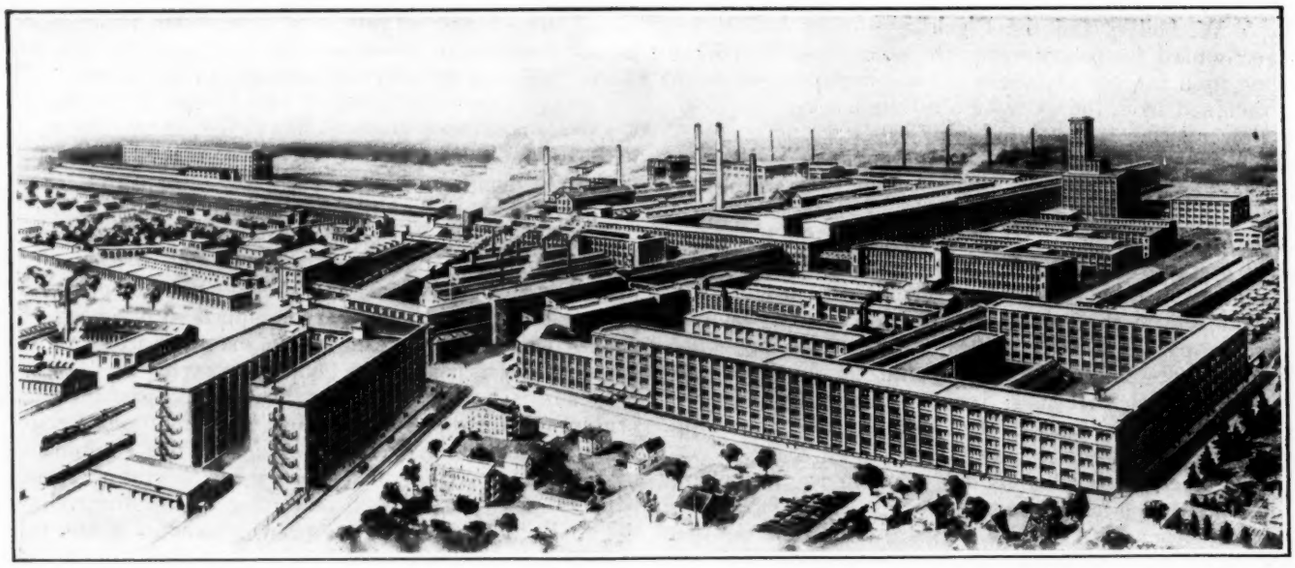


*Fig. 2—Airplane view of the plant of the Winchester Repeating Arms Company*

for radiators, for sand blasting and for many other purposes. Each department is piped with compressed air for cleaning and operating maintenance tools. To serve these purposes, in January, 1928, a total of 64,000,000 cu.ft. of free air was compressed.

The refrigeration equipment serves to cool quenching oils for the various heat-treating departments and to provide cold storage for finished dry batteries. Drinking water for the plant is also cooled.

Fuel gas is used for firing annealing furnaces, heat-treating furnaces, forge furnaces, and for numerous other processes requiring the application of smaller amounts of heat. In January, 1928, this work required a total of 34,500,000 cu.ft. of water gas and 107,000,000 cu.ft. of producer gas.

The heat content of the water gas is 275 B.t.u. per cu.ft. and of the producer gas, 90 B.t.u. per cu.ft. For high-temperature work, 1,500 deg. F. and above, the water gas is used. For lower temperatures a mixture of four parts of producer gas and one part of water gas is used. Mixing is done in a turbine-driven blower, the proportioning being automatically controlled. Producer-gas storage of 50,000 cu.ft. and water-gas storage of 210,000 cu.ft. is provided.

Contrary to what one would expect, the system used at the Winchester company for scheduling the production of the power services, to meet all the varied demands of the manufacturing, is simple and easy to operate. It has required, however, the keeping of accurate records for many years and an intensive study in the past of various processes developed in the plant, before it could be put into effect.

Briefly, the procedure is as follows: Some time before the first of the year the superintendent of power and plant maintenance receives, from the factory management, estimates of the production of each factory department for the ensuing year, by months. Based upon these estimates, by the application of factors determined by the results of past operation, a budget for the next year's operation is made and is submitted to the management, in December, for approval.

This budget sets up an allowance for labor, materials and other costs for each department coming under the superintendent of power and plant maintenance. For instance, the coal consumption is thus predetermined for a year ahead and the coal contracted for with deliveries scheduled in monthly quantities as shown in the budget. The accuracy of the system is proved by the fact that the over-all variation of actual operation from the budget or estimated operation has not been greater than 3 per cent for several years.

### How the Services Are Controlled

All the power services, together with the plant maintenance work, are under one head, the superintendent of power and plant maintenance, as shown in Fig. 1.

In the superintendent's office the necessary clerical work of the department is carried out. In addition, the work of planning and scheduling all the operations of the department is carried out here under the personal direction of a planning supervisor.

Reporting to the superintendent are the foremen of the following sub-departments: Boiler house, generating station, gas plant, painting, furnace and building construction, pipefitting, electrical repairs, sheet-metal work, millwrights and carpenters, box shop, belt lacers, servicemen and oilers, janitors, and transportation and material handling.

Each of these foremen is responsible to the superintendent for the economy of operation of his sub-department and for carrying out the plans and schedules of service determined in the superintendent's office. The main means, in addition to the personal oversight of the superintendent, for seeing that this responsibility is carried out, is a monthly foremen's meeting, in which each foreman must account to his chief and his fellows for the conduct of his work. This serves to bring achievement into the open and keep clearly before all the result of their joint efforts. It is probably only through these meetings that the budget system of control, well worked out as it is, is giving such good results for the Winchester Repeating Arms Company.

# Lime and Soda Treatment of Feed Water

By E. M. Partridge
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## Corrosive water and hard scale may result from partial softening

THE addition of lime and soda to water to soften it and improve its character as a boiler feed water supply is a matter of common practice. It is sometimes assumed that, since the addition of the full and proper amount of lime and soda necessary to soften the water completely causes an improvement in its character, the addition of any part of the chemicals involved effects an improvement in proportion. This is not necessarily true; in fact, the addition of amounts of lime and soda less than the charge necessary to effect complete softening may change the water so that it will form a harder boiler scale than if the water had not been treated at all and may cause a semi-corrosive water to become positively corrosive.

The reason for this lies in the fact that while a full charge of lime and soda will greatly reduce the amount of calcium and magnesium in solution and in properly treated water will leave less magnesium than calcium. These two substances are not removed in equal proportion by less than the full amount of treatment necessary for complete softening. Calcium is more completely removed than magnesium if anything short of the full lime treatment be given. This fact has a strong influence on the character of the resulting water if it be but partly softened. The first lime added reduces the bicarbonate existing naturally in the water to carbonates. Since calcium carbonate is less soluble than magnesium carbonate, the first effect is to precipitate calcium carbonate and leave magnesium carbonate in solution.

To illustrate the points in question, a natural well water was taken and treated with varying amounts of lime and soda. In making the test, the charges of dry lime and soda were weighed out and mixed with the water by shaking in a stoppered bottle. The samples were then allowed to stand for 24 hours and filtered before analysis.

Preliminary experiments indicated that the addition of 0.36 gram of hydrated lime and 0.21 gram of soda ash per liter of water would soften the water to a hardness of 2.83 grains, or 48.4 p.p.m., and leave an excess of approximately one grain of caustic soda and 0.4 grain of soda ash in solution. This was taken as being satisfactory for indicating what could be accomplished by a complete treatment of the water, and fractional parts of the amount of lime and soda were then added, the treatment given varying according to the figures under *L* and *S* in Tables I and II. The numeral 1 represents complete treatment. Thus under column 2 complete treatment with both lime and soda was given. In column 3 the analysis of the water treated with six-sevenths of the full amount of lime and six-sevenths of the full amount of soda is given, and under column 4 the results obtained with three-fourths of the full amount of both lime and soda appear. The other columns represent the analysis of water treated according to the figures indicated.

To facilitate interpretation of the results, the analyses are reported in Table I in ionic form in parts per million and in Table II in theoretical combinations in terms of grains per U. S. gallon.

The analyses indicated in the various columns are of the same water in either table. To Table I has been added the Stabler coefficient *C* for corrosive and scale.

No extensive remarks concerning the results obtained and tabulated will be made because it is thought that those interested can draw their own conclusions from a study of the tables. Some of the major points of interest can be pointed out briefly.

The Stabler coefficient for corrosion *C* is obtained from the following equation:

$$C = H + 0.1116\ Al + 0.0361\ Fe + 0.0828\ Mg - 0.0336\ CO_3 - 0.0165\ HCO_3.$$

If *C* be positive, the water will certainly corrode the boiler.

If $C + 0.0503$ Ca be negative, no corrosion will occur on account of the mineral constituents in the water.

If *C* be negative, but $C + 0.0503$ Ca be positive, corrosion may or may not occur.

This formula indicates the possibility of corrosion occurring from the mineral constituents present in the water. Since the water contained no free acid, and iron and aluminum were not tested for, only calcium, magnesium, carbonates and bicarbonates need be considered in the formula. It will be noted that the raw water, which was semi-corrosive in the natural state, became positively non-corrosive only in columns 2, 7 and 10, where the full amount of soda ash was added. It remains semi-corrosive in columns 6 and 9 where the full lime treatment and from three-fourths to one-half the full soda ash treatment was given, while in columns 3, 4, 5 and 8, where less than the full amounts of lime and soda treatment were given, the treated water is positively corrosive.

These results are indicated by the theoretical analyses reported in Table II. The Stabler formula for corrosion calls those waters positively non-corrosive in which the alkalinity is more than equivalent to the calcium and magnesium present. In the theoretical combinations given, this would mean the analyses would show the presence of one form or another of sodium alkaline salts such as sodium bicarbonate or sodium carbonate. Since the addition of lime alone in amount sufficient to cause any softening does not increase the alkalinity of the

natural water, but rather decreases it by removing bicarbonates from solution until an excess of lime is added, whereupon the excess appears as calcium hydrate, it is apparent why the addition of lime alone, particularly the addition of less than the amount to cause complete softening, and even the full amount of lime when less than the full amount of soda ash is added, will not form a water that is positively non-corrosive by the standards of the Stabler formula. The addition of the full amount of soda ash is, however, certain in every case to render the water non-corrosive as judged by this formula, since it is an amount that is intended to be sufficient not only to neutralize any permanent hardness in the water, but also to leave a slight excess of soda ash or sodium carbonate. Even though the reaction product separates from solution, the excess is soluble and remains active.

TABLE I—WATER ANALYSES

Parts per million in ionic form

| | | 1 L. 0 S. 0 | 2 L. 1 S. 1 | 3 L. ⅔ S. ⅔ | 4 L. ¾ S. ¾ | 5 L. ½ S. ½ | 6 L. 1 S. ½ | 7 L. ½ S. 1 | 8 L. ½ S. ¾ | 9 L. 1 S. ¾ | 10 L. ¾ S. 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity to phenolphthalein | | 0.0 | 53.0 | 37.6 | 34.2 | 34.2 | 41.1 | 85.4 | 59.0 | 61.6 | 61.6 |
| Alkalinity to methyl orange | | 408.0 | 77.0 | 82.1 | 84.7 | 151.3 | 65.8 | 311.0 | 229.0 | 82.1 | 121.5 |
| Hydroxide | OH | 0.0 | 9.7 | 0.0 | 0.0 | 0.0 | 5.5 | 0.0 | 0.0 | 14.1 | 0.6 |
| Carbonate | $CO_3$ | 0.0 | 28.4 | 45.2 | 41.0 | 39.9 | 29.8 | 103.5 | 71.4 | 24.6 | 71.8 |
| Bicarbonate | $HCO_3$ | 498.0 | 0.0 | 8.3 | 19.9 | 101.2 | 0.0 | 168.6 | 135.2 | 0.0 | 0.0 |
| Sulphate | $SO_4$ | 402.0 | 402.0 | 402.0 | 402.0 | 402.0 | 402.0 | 402.0 | 402.0 | 402.0 | 402.0 |
| Chloride | Cl | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.9 | 8.4 | 8.4 | 8.4 | 8.4 |
| Calcium | Ca | 177.5 | 16.4 | 9.2 | 6.9 | 11.0 | 86.0 | 4.8 | 4.8 | 71.2 | 6.6 |
| Magnesium | Mg | 92.5 | 1.8 | 26.1 | 36.8 | 68.2 | 2.8 | 64.0 | 68.0 | 1.7 | 24.0 |
| Sodium | Na | 0.9 | 32.9 | 175.0 | 159.0 | 124.0 | 123.0 | 214.0 | 168.0 | 150.0 | 199.0 |
| Hardness in terms of calcium carbonate | $H$ | 825.0 | 48.4 | 130.6 | 168.7 | 309.5 | 227.0 | 275.0 | 241.4 | 185.0 | 115.0 |
| Free carbon dioxide | $CO_2$ | 75.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Coefficient of corrosion* | | S | N | C | C | C | S | N | C | S | N |
| Scale (lb. per M gallons) | $Sc$ | 5.64 | 0.43 | 0.59 | 0.67 | 1.22 | 2.16 | 1.00 | 1.06 | 1.77 | 0.49 |
| Hard scale (lb. per M gallons) | $Hs$ | 6.00 | 0.03 | 0.60 | 0.69 | 1.14 | 1.87 | 0.88 | 1.08 | 1.19 | 0.33 |
| Coefficient of scale hardness | $h$ | 1.06 | 0.07 | 1.02 | 1.03 | 0.94 | 0.86 | 0.88 | 1.02 | 0.67 | 0.67 |

*S*, semi-corrosive; *C*, positively corrosive; *N*, positively non-corrosive.

TABLE II—WATER ANALYSES

Theoretical combinations, gr. per U. S. gallon

| | | 1 L. 0 S. 0 | 2 L. 1 S. 1 | 3 L. ⅔ S. ⅔ | 4 L. ¾ S. ¾ | 5 L. ½ S. ½ | 6 L. 1 S. ½ | 7 L. ½ S. 1 | 8 L. ½ S. ¾ | 9 L. 1 S. ¾ | 10 L. ¾ S. 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Calcium hydrate | $Ca(OH_2)$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.00 | 0.00 | 1.48 | 0.00 |
| Calcium carbonate | $CaCO_3$ | 0.00 | 2.40 | 1.35 | 1.00 | 1.60 | 2.90 | 0.70 | 0.70 | 2.40 | 0.95 |
| Calcium bicarbonate | $Ca(HCO_3)_2$ | 38.75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Calcium sulphate | $CaSO_4$ | 2.86 | 0.00 | 0.00 | 0.00 | 0.00 | 15.30 | 0.00 | 0.00 | 8.18 | 0.00 |
| Magnesium hydrate | $Mg(OH)_2$ | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.43 | 0.00 | 0.00 | 0.24 | 0.06 |
| Magnesium carbonate | $MgCO_3$ | 0.00 | 0.00 | 2.57 | 2.53 | 7.08 | 0.00 | 7.93 | 5.22 | 0.00 | 4.78 |
| Magnesium bicarbonate | $Mg(HCO_3)_2$ | 0.00 | 0.00 | 0.58 | 1.39 | 11.10 | 0.00 | 8.73 | 9.52 | 0.00 | 0.06 |
| Magnesium sulphate | $MgSO_4$ | 26.77 | 0.00 | 3.41 | 5.90 | 0.00 | 0.00 | 0.00 | 4.39 | 0.00 | 0.00 |
| Sodium hydrate | NaOH | 0.00 | 0.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sodium carbonate | $Na_2CO_3$ | 0.00 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 |
| Sodium bicarbonate | $NaHCO_3$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.56 | 0.00 | 0.00 | 0.00 |
| Sodium sulphate | $Na_2SO_4$ | 0.00 | 34.70 | 30.60 | 27.70 | 21.25 | 21.52 | 34.70 | 29.45 | 26.15 | 34.70 |
| Sodium chloride | NaCl | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |
| Total solids* | $T.S.$ | 59.55 | 39.57 | 39.08 | 38.75 | 37.41 | 40.89 | 52.73 | 46.06 | 39.27 | 41.71 |
| Hardness as $CaCO_3$ | $H$ | 48.32 | 2.83 | 7.64 | 9.87 | 18.10 | 13.29 | 16.08 | 17.06 | 10.81 | 6.72 |
| Carbon dioxide | $CO_2$ | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Incrustants (lb. per M gallons) † | Inc. | 7.67 | 0.38 | 1.10 | 1.44 | 2.15 | 2.69 | 1.95 | 2.26 | 1.76 | 0.83 |
| Non-incrustants (lb. per M gallons) † | Non-inc. | 0.12 | 5.65 | 4.46 | 4.07 | 3.20 | 3.15 | 5.57 | 4.33 | 3.85 | 5.13 |

* All bicarbonates calculated as carbonates.

† Figures obtained by dividing sum of calcium and magnesium salts by seven, all bicarbonates being taken as carbonates.

The analyses in columns 3, 4, 5 and 8 which represent the waters that were made positively corrosive as judged by the Stabler formula, are seen by the theoretical combinations of Table II to be those in which magnesium sulphate is prominent and is present in amounts in excess of the equivalent of the calcium carbonate present. Magnesium sulphate is assumed to develop an acid reaction in the boiler, which can be neutralized by the calcium carbonate present so long as the latter is available, but when the calcium carbonate has been converted to calcium sulphate with the attendant formation of magnesium oxide or hydrate and the escape of carbon dioxide has been exhausted, the water becomes definitely corrosive if magnesium sulphate remains present in excess.

Turning to Table I again, it is to be noted that each of the treatments, even when only one-half the complete amount of lime and soda was added, effected a considerable reduction in the amount of scale that might form from the use of the water in question. Stabler's formulas for determining the amount of scale formed, the amount of hard scale and the coefficient of scale hardness, are given here for convenience:

Scale $S_c$

$$S_c = 0.00833\ S_m + 0.00833\ C_m + 0.0107\ \text{Fe} + 0.0157\ \text{Al} + 0.0138\ \text{Mg} + 0.0246\ \text{Ca}$$

In this formula Ca should not exceed $0.668\ CO_3 + 0.328\ HCO_3 + 0.417\ SO_4$.

**(Suspended matter $S_m$, Colloidal matter $C_m$, Iron Fe and Aluminum Al, were not determined in the samples analyzed and need not be figured in the computation of the values for "$S_c$," etc. They are present in relatively low amounts and unimportant.)**

Hard Scale $H_s$

$$H_s = 0.00833\ SiO_2 + 0.0138\ \text{Mg} + (0.016\ \text{Cl} + 0.0188\ SO_4 - 0.0246\ \text{Na} - 0.0145\ \text{K})$$

In this formula the value for the parenthesis must not be less than zero, nor should it exceed $0.0118\ SO_4$ or 0.0283 Ca.

Coefficient of Scale Hardness $h = H_s \div S_c$

Soft scale: $h$ not more than 0.25.

Medium scale: $h$ not less than 0.25, but not more than 0.5.

Hard scale: $h$ more than 0.5.

It will be noted that in every instance where less than the full amount of treatment was given, the coefficient of scale hardness $h$ is more than 0.5 and represents,

therefore, a hard scale. A study of the Stabler formula indicates that it is presumed that magnesium will precipitate or will be present in the final scale product as magnesium oxide and it, together with any calcium sulphate which may be regarded as present by the formula, is taken as being hard scale-forming constituents. An examination of the theoretical combinations in Table II indicates that where the lime treatment is deficient, magnesium compounds remain in solution. When the lime treatment is complete and the soda ash treatment is deficient, calcium sulphate appears.

It is apparent that while a partial lime soda treatment reduces the amount of scale that will form, that which does form may be harder and of a less desirable character than will form from the raw water. The particular untreated water employed for these tests would, by the Stabler formula, form a very hard scale, but as stated in the opening paragraph, it is possible that by partial treatment a water may be brought into such condition that the treated water will form a harder scale than the untreated water if its scale-forming propensities be judged by the Stabler formula.

Within the recent past the author had occasion to make an investigation of the results being obtained by lime soda softeners on a division of a Mid-Western railway. Analyses of the untreated and treated water at two of these plants are given in Tables III and IV. These plants are listed in the tables as Plant A and Plant B, Table III being the report in parts per million in ionic form and Table IV the same results reported in theoretical combination. It will be noted that both raw water supplies required treatment chiefly by lime with a relatively small amount of soda ash. Trouble from foaming had been reported along the division, and the trouble was attributed to the use of softened water from the lime soda softeners. Treatment had been reduced in order to overcome this foaming, and the results are indicated by the analyses in the tables. By Table III it is seen that while at both plants the amount of scale-forming matter was reduced approximately to one-fourth the original amount, the water has been changed in character at both plants from a semi-corrosive water to a positively corrosive one and the coefficient of scale hardness is higher in the treated than in the untreated waters. The coefficient of scale hardness has, in fact, practically doubled in both instances on account of the water treatment employed.

TABLE III—ANALYSIS OF RAILWAY FEED WATER

Parts per million in ionic form

| | | Plant A | | Plant B | |
|---|---|---|---|---|---|
| | | Untreated | Treated | Untreated | Treated |
| Alkalinity to phenolphthalein | P | 0.0 | 22.2 | 0.0 | 30.8 |
| Alkalinity to methyl orange | M | 291.0 | 92.4 | 342.0 | 106.1 |
| Carbonate | $CO^3$ | 0.0 | 66.1 | 418.0 | 51.8 |
| Bicarbonate | $HCO^3$ | 354.0 | 16.7 | 418.0 | 54.1 |
| Sulphate | $SO^4$ | 112.2 | 112.2 | 175.1 | 175.1 |
| Chloride | Cl | 7.2 | 7.2 | 3.6 | 3.6 |
| Calcium | Ca | 89.0 | 13.1 | 122.2 | 10.3 |
| Magnesium | Mg | 35.3 | 29.1 | 40.8 | 40.8 |
| Sodium | Na | 23.0 | 31.0 | 38.2 | 46.0 |
| Hardness as calcium carbonate | *H* | 361.0 | 153.0 | 449.0 | 194.0 |
| Coefficient of corrosion* | | S | C | S | C |
| Scale (lbs. per M gallons) | *Sc* | 2.68 | 0.71 | 3.33 | 0.82 |
| Hard scale (lbs. per M gallons) | $H_s$ | 1.42 | 0.77 | 1.75 | 0.85 |
| Coefficient of scale hardness | *h* | 0.53 | 1.08 | 0.53 | 1.04 |

* *S*, semi-corrosive; *C*, positively corrosive.

In Table IV these facts are reflected in the disappearance of the temporary hardness due to calcium, while the temporary hardness due to magnesium is only partly reduced and the magnesium sulphate is left almost unchanged.

The accompanying tables of analyses support the statement that a water may be made actually more corrosive in character by partial softening with lime and soda and that lime soda softening does not insure the formation of a soft sludge in the boiler unless the treatment be complete. Incomplete treatment may result in the formation of a smaller amount of a harder scale, with the use of the treated water, than was obtained by the use of the untreated water.

TABLE IV—ANALYSIS OF RAILWAY FEED WATER

Theoretical Combinations, grains per U. S. gal.

| | | Plant A | | Plant B | |
|---|---|---|---|---|---|
| | | Untreated | Treated | Untreated | Treated |
| Calcium carbonate | $CaCO_3$ | 0.00 | 1.90 | 0.00 | 1.50 |
| Calcium bicarbonate | $Ca(HCO_3)_4$ | 21.20 | 0.00 | 26.38 | 0.00 |
| Magnesium carbonate | $MgCO_3$ | 0.00 | 2.27 | 0.00 | 1.76 |
| Magnesium bicarbonate | $Mg(HCO_3)_2$ | 5.84 | 1.17 | 5.11 | 3.80 |
| Magnesium sulphate | $MgSO_4$ | 5.41 | 4.20 | 7.60 | 7.15 |
| Sodium sulphate | $Na_2SO_4$ | 3.31 | 4.75 | 6.18 | 7.89 |
| Sodium chloride | NaCl | 0.70 | 0.70 | 0.35 | 0.35 |
| Total solids | *T. S.* | 25.78 | 14.48 | 33.37 | 20.83 |
| Hardness as calcium carbonate | *H* | 21.51 | 8.94 | 26.23 | 11.33 |
| Incrustants (lbs. per M gallons)* | Inc. | 3.11 | 1.29 | 3.83 | 1.80 |
| Non-incrustants (lbs. per M gallons)* | Non-inc. | 0.57 | 0.78 | 0.93 | 1.32 |

* All bicarbonates computed as carbonates.

It is important that lime and soda softening be carried out in a softener that is capable of allowing accurate and complete treatment with the full and proper amount of chemicals to bring about full softening. It is likewise important that this plant be operated with care and attention so as to obtain results justifying the expense of the installation.

When on some occasions it is desirable to have partial softening of a water supply, the possibility of completely softening part of that water supply and mixing it with untreated water should be considered. Such a procedure does not disturb the ratio of calcium to magnesium in the raw water to such an extent as does partial softening, as discussed in this article, and may under some circumstances prove to be a more desirable method of proceeding.

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THE A.S.M.E. BOILER CODE has heretofore allowed autogenous welding in cases where the stress or load is carried by other construction that conforms to the requirements of the code, and where the safety of the structure is not dependent upon the strength of the weld. Recent revisions of the code permit fusion welding of certain parts of the boiler structure as indicated in the following addenda.

Joints between the doorhole flanges of furnace and exterior sheets may be butt or lapwelded by the fusion process provided these sheets are stayed or otherwise supported around the doorhole opening and provided the distance from the flange to the surrounding row of stays or other supports does not exceed the permissible staybolt pitch as per par. P-199. If such joints are lapwelded the exterior sheet flange should preferably be placed on the outside or next to the door opening and the firebox sheet flange on the interior next to the water. Autogenous welded construction may be used in lieu of riveted joints in the fireboxes of internally fired boilers, provided the welds are between two rows of staybolts, or in the case of flat surfaces the weld is not less than one-half of a staybolt pitch from the corner.

# What Do You Know?

By L. H. Morrison

*The answers are on page 526*

Ques. 1—At what point in its circle of travel is the crankpin when the piston is traveling the fastest?

Ques. 2—Why is not a throttle-governed engine with a $D$ valve as efficient as a variable cutoff engine, such as a shaft-governor automatic engine using a balanced valve?

Ques. 3—What is a mixed-pressure turbine?

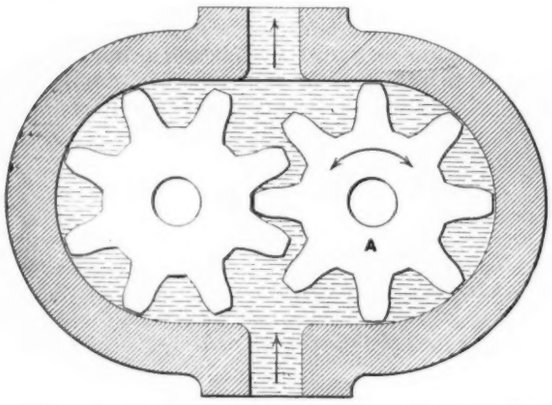
Ques. 4—Suppose a cylindrical tank resting horizontally on two saddles is 5 ft. diameter by 20 ft. long and weighs 13,000 lb. when empty. What will be the pressure on the two saddles when the tank is filled with air at 100 lb. pressure, assuming the temperature to be 60 deg. F.?

Ques. 5—Why, after hardening a chisel, do you "temper" it by heating it slightly for a short time?

Ques. 6—Under what circumstances was the "Underwriters Fire Pump" originated?

Ques. 7—What is the logarithm of a number?

Ques. 8—Is it permissible under the Boiler Code to use in the line to the water column a straight through-




*The rotary pump referred to in Question 10*

blow valve which operates with a lever-controlled cross-sliding disk, the lever being fitted with a locking device that permits it to be locked in open position and shows clearly by an index when the lever is in the open position.

Ques. 9—Specify five ways in which the power factor of a load consisting of induction motors may be improved?

Ques. 10—With the water passing out of the gear pump in the direction shown in the illustration, should the gear $A$ move clockwise or anti-clockwise?

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An Important Advantage of Ball-Bearing Motors arises from the manner in which they are lubricated. Grease is used rather than oil. Grease lubrication in combination with tightly sealed bearing housings makes the motor free from oil leakage, dripping or spattering. Grease lubrication likewise prevents oil from spattering outside of the motor. Ball-bearing motors are usually provided with sufficient grease in the bearing housings to lubricate the bearings for a year of ordinary service.

# Combining Power and Process Steam Requirements

By Eugene Weber*

During 1927 the Gates Rubber Company, Denver, Colo., decided to generate its own power service, since much of it could be developed from steam going to the rubber process departments.

The annual power consumption of the plant is approximately 8,000,000 kw.-hr. and the steam required for process work in the manufacture of rubber totals about 120,000,000 lb. per year. This steam is needed at the vulcanizers at 100 lb. pressure.

Ground was broken in August, as shown in Fig. 1, and several steps in the undertaking are shown in the other illustrations. The plant is now completed, and as soon as it has been in operation long enough to permit accurate data to be recorded, a story of the operating features, including itemized costs, will be published in *Power*.

The new power plant consists of three General Electric turbine generators; two are rated 1,000 kw. condensing, and the third is a 500-kw., 125-lb. back-pressure machine. These turbines will be driven by steam at 400 lb. pressure and 700 deg. F. total temperature, supplied by two boilers. The boilers are Erie City horizontal water-tube type with Sturtevant economizers and Combustion Engineering superheaters installed over Green Engineering chain-grate-stokers with induced draft for using Colorado lignite with a heating value of about 9,000 B.t.u.

The two 1,000-kw. turbines will be installed over surface condensers. The cooling water will be recooled in a forced-draft cooling tower. The 500-kw. machine will exhaust at 125 lb. pressure into the steam line leading to the factory.

The small turbine will carry a load depending upon the demand for process steam, while the condensing turbines will carry the remainder of the load. With a demand of 120,000,000 lb. of steam for the process work, the small back-pressure turbine will generate about 2,000,000 kw.-hr. per year. Inasmuch as the heat content of the steam discharged is utilized in process work, the coal consumption per kilowatt-hour produced by this machine is small, figuring about seven-eighths of a pound of coal per kilowatt-hour.

In operation, the 500-kw. turbine will run continuously, carrying loads in proportion to the process steam demand. Both the 1,000-kw. machines will be in service for about eight hours during the day, and only one of them will be used during the remaining sixteen hours. Power will be generated at 2,300 volts and distributed underground to the factory.

The new power plant, in addition to furnishing process steam, will also supply all water required for the hydraulic operation of the various presses and vulcanizers. The necessary water for operating the plant had previously been purchased. As an additional water supply there was recently installed a motor-driven vertical centrifugal pump, water being taken from a well a short distance from the mill.

The design and construction of the plant was in charge of Wood & Weber, Inc., consulting engineers, Denver.

*Wood & Weber, Consulting Engineers, Denver, Colo.

# Building the Gates Power Plant

*Fig. 1 (Above)—Breaking ground in August*

*Fig. 2 (Below)—By Sept. 14 the excavation was about completed*

*Fig. 3 (Left)—On Oct. 15 the concrete piers had been poured*

*Fig. 5 (Below)—The plant as it looked on Dec. 12*

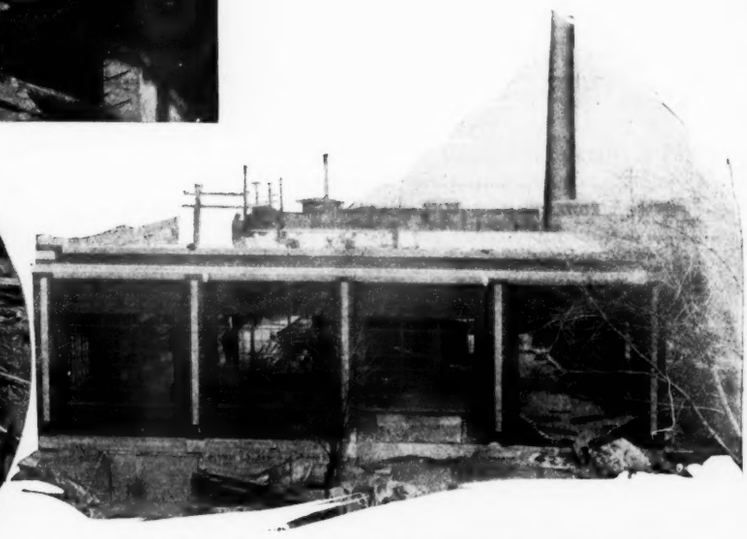
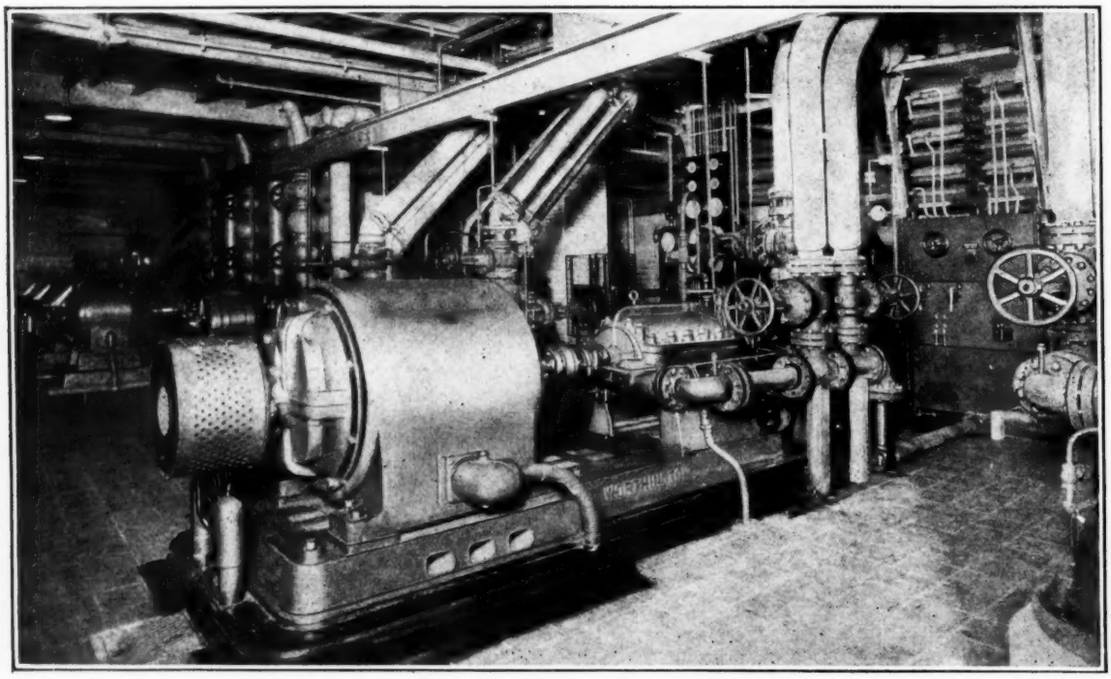


*Fig. 4 (Left)—The wiring conduits were in place by Nov. 12*

# ELECTRICAL
## *Operation and Maintenance*



# *Selecting a Power Supply for* Power-Plant Auxiliaries

By H. L. SMITH
*Industrial Engineering Department, General Electric Company*

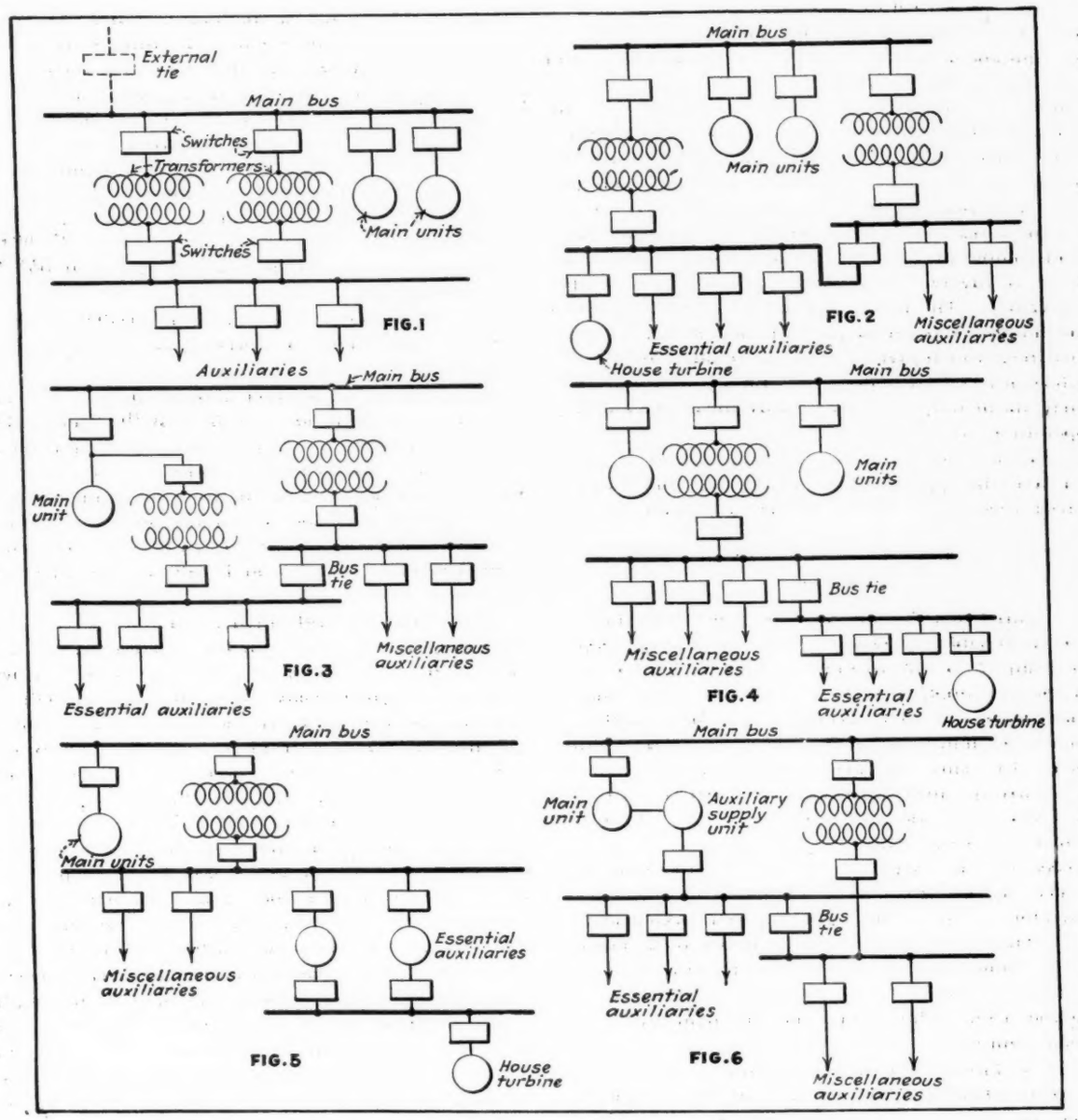
ASIDE from the main generating units, control boards, switchgear and transformers, if used, the principal machines and devices used in steam stations are commonly known as station auxiliaries. Certain of these auxiliaries cannot go out of service without affecting the ability of the main generating units to carry load. It is essential to keep some auxiliaries in operation if the main units are to be kept in operation condensing, even though the load may have been temporarily lost. In the case of boiler-feed pumps, with the high rate of evaporation now used in boilers, the shutdown of these pumps for more than a brief interval may cause the water level in the boiler to fall to a dangerous level. For convenience these units are classed as essential auxiliaries. Auxiliaries essential to the continuous operation of the plant include boiler-feed pumps, circulating-water pumps and hotwell pumps. For continuous operation of the plant and at the same time carrying load the essential auxiliaries comprise forced- and induced-draft fans, stokers or coal feeders, exciter sets, vacuum pumps, deaërator pumps, and coal-pulverizer equipments where unit pulverizers are used.

The remaining auxiliaries may be shut down for a period varying with the conditions, without materially affecting the operation of the plant and are called "non-essential auxiliaries." These embrace coal-handling and preparation equipment, including conveyors, coal crushers, clinker grinders, pulverizers, etc.; service and evaporator pumps; air compressors; ventilating fans; fire pumps, etc.

The problem of applying electric drive to auxiliaries is different in some respects from the application of electric drive to equipments in industrial plants. Industrial plants where the power is purchased from central station or is received from their own power plants, assume continuous electrical service and, should an in-

# ELECTRICAL *Operation and Maintenance*

terruption occur to the power supply, consideration in manufacturing processes usually predominates and determines the length of interruption and the method of again starting the equipment and putting it into service. For example, in certain chemical processes it may result in the ruin of batches of material; therefore, every precaution must be taken to insure continuous service, and this service must be resumed after any interruption as




*Figs. 1 to 6—Diagrams showing different methods of supplying auxiliary power*

Fig. 1—Power supplied through transformer from the main busbars. Fig. 2—Same as Fig. 1, but a house turbine-generator has been added to supply the essential auxiliaries should the main units fail. Fig. 3—Transformer on main bus is supplemented by a transformer connected to the generator leads for auxiliary-power supply. Fig. 4—House turbine generator connected so that in case of failure of power to the main busbars the essential auxiliaries only will be supplied from the house-turbine generator. Fig. 5—Essential auxiliaries connected between the house turbine generator bus and the bus supplied through transformers connected to main bus. Fig. 6—Auxiliary-supply generator driven by main turbine provides auxiliary power in combination with a bank of service transformers.

The function of the power plant is to furnish continuous and reliable power, and an interruption of only a few seconds may cause a great deal of inconvenience. quickly as possible. There is nothing involved in the operation of the power plant which prevents the auxiliaries from being restarted immediately.

# ELECTRICAL *Operation and Maintenance*

The source of power supply for the auxiliaries and the type of motor and control used must, therefore, be selected with these facts in view, which means that motors and control for the auxiliaries must be chosen from a different point of view from that taken in applying motors and control to equipment in industrial plants.

Some power plants have gone to extreme simplicity in the equipment, securing simplicity of operation and low first cost at the sacrifice of operating characteristics and efficiency. Other stations have gone to the opposite extreme, installing complicated equipment to improve operating characteristics and efficiency, duplicating the equipment for reliability, sacrificing first cost and simplicity. It is believed that the best practice is to use neither the most efficient equipment if it involves high cost and complicated control, nor the cheapest and most simple if it involves low efficiency and less desirable characteristics. The better practice will generally be to use the simplest type of motor and control and arrangement of these which gives, as far as possible, the desired characteristics and efficiency, yet avoiding complications that may mean only a slight improvement in efficiency and operating characteristics.

The power supply for the auxiliaries will be considered first; the application of motors and control to the auxiliaries themselves will be discussed in later articles.

## Auxiliary Power Supply Made Reliable as Possible

It is essential that the power supply for the auxiliaries be made as reliable as possible. As any electric supply may be subject to interruption, it is desirable to have an emergency supply independent of the main supply available for the essential auxiliaries. In the central stations and large industrial power plants this can be readily arranged. In many industrial plants, however, which are of relatively small capacity as compared with the central station, it is not always practicable or economical to furnish a separate emergency supply. In addition, stage bleeding for feed-water heating is not generally used, since the increase in investment is not warranted in small units. Hence the most essential auxiliaries in industrial power plants—that is, the boiler-feed pumps, circulating pumps and exciters—would most likely be steam driven. This practice is necessary to permit restarting the plant without aid from the main unit after a complete shutdown.

In central stations and in large industrial plants care must also be taken in laying out the auxiliary supply to make possible the starting of the plant after a complete shutdown without the aid of the main turbines. For this purpose there should be furnished either a small non-condensing house turbine for emergency starting or else sufficient steam-driven auxiliaries. The latter may consist of duplex-drive units, using both a turbine and a motor connected to the same unit. The control for this unit should be so arranged that under normal operating conditions the motor carries the load, but in case of loss of power the steam turbine automatically picks up the load and drives the auxiliaries. The motor picks up the load again when the auxiliary power supply is reestablished. The following are a few of the arrangements most commonly used:

## Alternating-Current Supply

One of the simplest methods is where the power is supplied from the main generators through transformers. This method involves the minimum additional equipment and the auxiliary power used is generated at the maximum efficiency. Fig. 1 shows such a layout, which would be applicable to the average industrial plant.

Here it is essential to have a certain number of boiler-feed, hotwell and circulating-water pumps steam driven or else use duplex drive so as to keep these running through any disturbances that may occur in the electrical system. A tie-in with an external source of power may also be provided.

The remaining arrangements for auxiliary power supply will apply more to central stations and large industrial power plants.

Fig. 2 shows a method similar to Fig. 1, with the addition of a small house turbine of the non-condensing type, which would be used for emergency starting only.

A further modification is shown in Fig. 3, in which the auxiliary power is taken from the main unit between the generator and the oil circuit breaker. Even if it should become necessary to disconnect the generator from the bus, power would still be available for the auxiliaries.

Fig. 4 shows a still further modification, in which a spinning house turbine generator is floated on the bus to furnish power for the essential auxiliaries. Power is normally supplied from the main bus through transformers, the generator of the house turbine runs as a synchronous motor with no load but full field excitation, and just sufficient steam entering the turbine to keep the wheels cool. In case of failure of power through the service transformers, the house turbine generator tends to pump back on the main bus. This reverse flow of power opens the automatic bus-tie oil circuit breaker, disconnects the bus for the essential auxiliaries from the rest of the system, and power for these auxiliaries is then furnished by the house turbine generator.

This plan allows power for the auxiliaries to be generated at the maximum efficiency for normal conditions, while continuity of auxiliary power supply is assured through the house turbine generator. This turbine generator also provides a means for emergency starting of the auxiliaries. This has the added advantage that a spinning house turbine generator can be used to improve the power factor of the system as the generator acts as a synchronous condenser when running idle. As the auxiliaries are generally induction motors and as the loads are usually overmotored, the power factor of the auxiliary load is comparatively low, and any improvement in the power factor is desirable. This turbine generator, especially, is designed for 0.8 leading power factor or lower, provides a ready means for this improvement.

Fig. 5 shows another method using a double bus. One bus is fed by the house turbine generator, the other

# ELECTRICAL *Operation and Maintenance*

from the main unit through transformers. This arrangement permits of rapid transfer of motors from one bus to the other in case of trouble. In certain cases it may be economical to keep the house turbine shut down but arranged for automatic starting in emergency.

Another system uses a separate house-service generator driven by the main unit. This system is shown in Fig. 6 and provides a reliable and efficient source of power. High efficiency is secured, as the house-service generator is driven by the main turbine, which is the most efficient primary unit. It also gives a power supply that is isolated from the main units and is therefore unaffected by system disturbances.

An emergency supply is available from the main bus through service transformers. This house-service generator should be so arranged that, if voltage on this generator is lost for any reason, its oil circuit breaker will open and close the bus-tie oil circuit breaker and throw the essential auxiliaries over to the bus fed by the house-service transformers. As in the previous system, it is necessary to furnish a non-condensing house turbine or sufficient steam-driven units to start the station without the use of the main unit.

### Direct-Current Supply

While the majority of installations use alternating current for the auxiliaries, direct current has been used in a few installations. When direct current is used for the essential auxiliaries, it should be generated either by a separate direct-current turbine generator or by a separate direct-current generator connected to the main unit. The advantages of using direct current for the essential auxiliaries are:

1. The power for the auxiliaries is isolated from the main bus, is not, therefore, subject to any of the main-bus disturbances, and gives a reliable source of power.

2. For certain units such as the draft fans, stokers and fuel feeders, where a wide speed range is required (in some cases as high as 5 to 1), the direct-current motor is particularly suitable, as the speed range may be readily and simply secured by field control. For such drives the efficiency at reduced speed is considerably better than can be secured by any alternating-current motor.

A motor-generator set receiving power from the main bus could be used as an emergency source of direct current. This, however, should not be used as the main supply as one of the main advantages of direct current is then lost, that is, the auxiliary supply would be tied up and subject to system disturbances. Where only a relatively small amount of direct current is required—for example, for driving stoker and fuel-feeder motors—then a motor-generator set is justified.

The disadvantages of the direct-current system are:

1. The initial cost is considerably more than for alternating current, not only in the generating equipment, motors and control, but also in the bus system and cables. This is particularly true where the auxiliaries are of large capacity. On alternating current high voltage can be used on the large units, whereas, at present, direct-current motors are limited to relatively low voltages and a large amount of copper must be used in the cables and bus system.

2. The auxiliary power cannot be generated at as high an efficiency as with alternating current, although this is offset to some extent by the better over-all efficiency on the drives where large speed reductions are required.

3. Direct-current motors and control are not as simple as alternating-current motors and control, and the maintenance of the direct-current equipment would be greater, especially if the equipment is located where there is a great deal of dust.

### Choice of Voltage

The voltage to be used depends upon the generated voltage, horsepower rating of the auxiliary motors, total auxiliary load and the length of the cable runs, and it is a question of balancing up the relative cost to see which would be the most economical. The cost of 2,200-volt motors is more than for low-voltage motors. This is especially true in the smaller sizes. A 30-hp. 2,200-volt motor may cost from 25 to 40 per cent more than the corresponding low-voltage motor. This difference, however, becomes less as the capacity increases until, with motors of 300-hp. capacity and above, there is practically no difference.

It is not practicable to use 2,200 volts for motors smaller than 25 hp. at 1,200 r.p.m., as the coils cannot be made of sufficient mechanical strength, therefore a certain number of low-voltage motors must be used. Control will also be more expensive for 2,200 volts than for low voltage in the small and medium-sized motors. In sizes of from 400 to 500 hp. or larger, 2,200-volt control may be the less expensive.

Against the increased cost of motors and control for 2,200 volts is the saving in conduit and cable and, in some cases, switching. This saving will generally justify the use of 2,200 volts on motors rated 200 hp. or higher, but this will depend upon the particular layout of the plant. Approximately 60 per cent of the central stations use 2,200 volts for auxiliary power.

The short-circuit interrupting capacity required will also be a consideration. Often, by the use of 440 volts, on which the short-circuit currents are limited, smaller and less expensive control can be used than would be possible on 2,200 volts.

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With 40 per Cent Normal Volts impressed on the stator terminal, a general-purpose polyphase induction motor will take approximately 100 per cent normal full-load current and develop about 30 per cent full-load torque; at 60 per cent normal volts, 250 per cent full-load current and develop 52 per cent full-load torque; at 80 per cent normal volts the current will be approximately 400 per cent and the torque 125 per cent; and at 100 per cent normal volts the current will be 600 per cent and develop about 200 per cent full-load torque. However, this varies somewhat with the design of the motor and should be taken only as approximate.

# REFRIGERATION
## *Equipment and Operation*

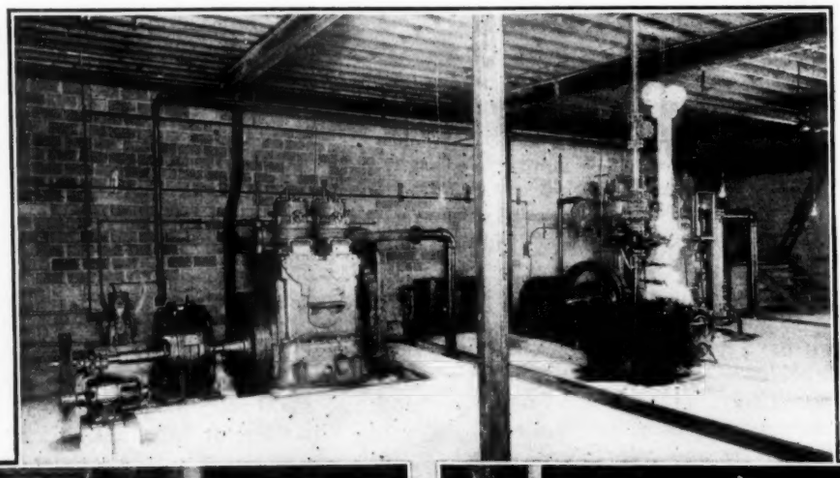
## *Addition to an Ice Plant*

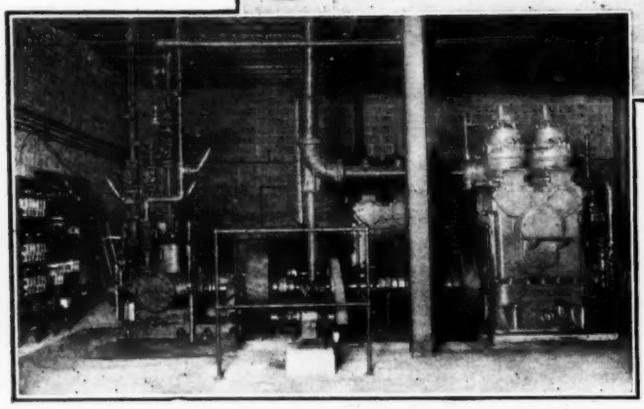
# Returns 100 Per Cent Profit

By Edgar J. Kates
*Consulting Engineer*

TWO years ago the Nassau Consumers Ice Company built an oil-engine-driven ice plant at East Rockaway, New York, in the neighborhood of the rapidly growing suburban community of Long Beach. The plant capacity was 45 tons of ice per 24 hours, but in view of the likelihood of expansion, the engine room was built double the size necessary to house the initial equipment. The plan of the original layout is shown in Fig. 4, while Figs. 1 and 3 show the two machines. The main unit was a 138-hp., Worthington three-cylinder vertical Diesel engine direct connected to an 11x12-in. Carbondale double-acting horizontal ammonia compressor running at 300 r.p.m., and a 60-hp. two-cylinder Diesel of the same make direct-connected to a 40-kw., 60-cycle 360 r.p.m. generator. All auxiliary equipment throughout the plant was motor-driven and was supplied from this generating unit. The freezing tank contained 748 cans. Water for the ammonia condenser and for the engine jackets was pumped from wells at a temperature of 52 deg. F.

The plant was put into service in July, 1926. Ice sales grew so rapidly that by the end of the season it was evident that increased capacity would be needed the following year. Although it was realized that in a few years more the demand would warrant a plant of twice the capacity, it was not desired to make immediately such a large additional investment. A plant extension was therefore planned that would cost as little as possible. While the primary purpose of the extension was to increase the ice output, expediency suggested satisfying a number of other conditions as well, namely: The new unit should fit in with the future doubling of the size of the plant;





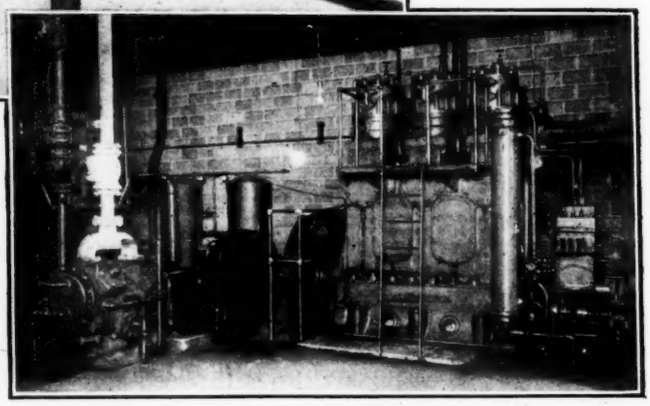


*Fig. 1 (Top)—View of plant before addition of new unit. Fig. 2 (Left)—The new engine, generator and compressor. Fig. 3 (Right)—The 138-hp. Diesel is direct connected to a horizontal compressor*

# REFRIGERATION *Equipment and Operation*

it should be able to furnish refrigerating capacity for a future large ice-storage house; it should be able to act as a spare generating unit, and it should provide a small compressor unit to be used in winter, and also in summer in case of accident to the main compressor.

A satisfactory solution of the problem was achieved by installing the combined compressor-generator unit shown in the foreground of Fig. 2. The location of this new unit is shown in broken lines in Fig. 4. This was a 60-hp. Diesel, a duplicate of the first one, and was direct-connected both to a 40-kw. generator and through a flexible coupling to a two-cylinder vertical single-acting pressor unit, to be installed when the plant capacity is to be doubled. Incidentally, by placing the new unit as shown, it was possible to set it on one of the original foundation slabs, thus saving the cost of a new foundation as well as avoiding the nuisance of doing excavating and mason work inside an active engine room.

When the plant is doubled in size and new freezing tanks, condensers, etc., are added, the electrical load will also be increased, and the unit recently installed will furnish the additional current required. For the present, however, it is being used to increase the ammonia compressor capacity of the plant, and thus the ice output.

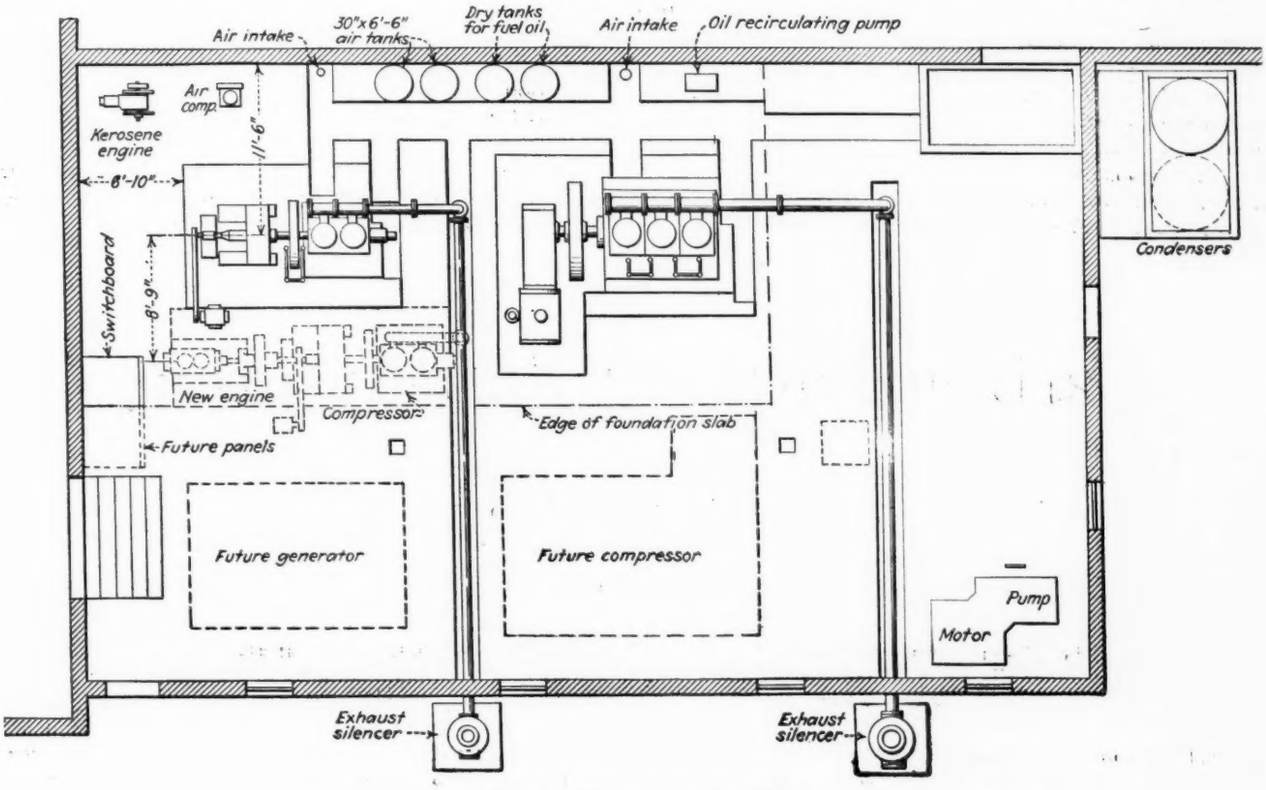



*Fig. 4—Plan of the ice plant*

Carbondale compressor of 32 tons refrigerating capacity. Power from the oil engine is delivered to either the generator or the compressor, but never to both. When driving the generator for short periods, the compressor is idled with the full-size bypass open, but if the generator is to be used for a long time, the compressor is easily disconnected by removing the bolts of the flexible coupling.

No changes were made in the brine coolers, freezing tanks or condensers, as it was desired to avoid any expense in this direction and to use the present equipment to its full capacity. Of course the additional gas passing to the condenser tends to increase the discharge pressure and to keep it down as much as possible, an automatic purger was installed.

As will be noted from Figs. 2 and 4, the new unit was so placed that ample room was left for a future compressor unit, to be installed when the plant capacity is to be doubled. Incidentally, by placing the new unit as shown, it was possible to set it on one of the original foundation slabs, thus saving the cost of a new foundation as well as avoiding the nuisance of doing excavating and mason work inside an active engine room.

When the plant is doubled in size and new freezing tanks, condensers, etc., are added, the electrical load will also be increased, and the unit recently installed will furnish the additional current required. For the present, however, it is being used to increase the ammonia compressor capacity of the plant, and thus the ice output.

If the large compressor is shut down through accident, the new unit will hold down the temperature of the brine and of the day-storage room and will maintain a moderate ice production. In the winter, when the ice demand is small, the large compressor can be shut down and both 60-hp. engines can be run, one driving a generator, the other a compressor. In the summer season, should anything happen to the original generating unit, the new machine can be used to take the entire electrical load, thus keeping the plant in normal operation except for some reduction in the ice output.

The compressor capacity of the new unit is somewhat greater than can be effectively used in the present freezing tank, and the reserve is available for supplying refrigeration to a large ice-storage house which it is proposed to build at a future date.

## REFRIGERATION *Equipment and Operation*

The performance of the new unit during the past season met all expectations. The brine temperature was reduced 3 deg. and the ice output increased 13 tons daily, making a total of 58 tons. The condenser pressure was found to be 13 lb. higher when both compressors were running than when only the large machine was in service. However, the automatic purger was exceedingly effective in eliminating the excess pressure that existed last year due to non-condensible gases. As a result, under the same conditions of suction pressure and temperature, the condensing water temperature also being constant, the discharge pressure, which was 140 lb. last year with only the large compressor in operation, is only 138 lb. this year with both compressors in use. The purger thus prevented any increase whatever in condenser pressure, in spite of the greater load.

The total fuel consumption increased practically in proportion to the ice output; it is about five gallons per ton of ice. The oil is rather expensive, being delivered in tank wagons over a long route, but even at the price of 8½c. a gal., the fuel cost per ton of ice is only 42.5c. As the plant is adjacent to a railroad, it is clear that a railroad siding to permit railroad tank-car deliveries of fuel at a price of about 6c. a gal., would soon pay for itself.

The only increase in labor cost occasioned by the new equipment was in ice-puller's wages. This amounted to 23c. per ton.

The entire cost of the plant enlargement was about $10,000, which is considerably less than the cost of a number of other plans that were considered, and is exceedingly low in comparison with the benefits secured.

The total increase in plant operating costs occasioned by the new equipment consisted of the extra cost of fuel and labor, amounting to 65c. per ton, plus the extra lubrication and repair costs, which are estimated at 10c., making a total of 75c. per ton of additional ice produced. On a basis of 200 days per year operation with enlarged production, the annual profit on the additional output of 2,600 tons will be over $8,000 and will pay back the investment in a little more than one year.

The plant extension was designed and supervised by the author, as consulting engineer, and was installed by W. C Comstock, the chief engineer of the plant.

# Carbon Dioxide Refrigerating Machines*

By J. C. GOOSMANN

### Early Experiments with Carbon Dioxide—Modern Compressor Designs—Increasing Machine Output

THE various early designs of refrigerating machinery are still well remembered by the present generation of engineers. Practically all of them are more or less recent history. As a matter of fact, it will be recalled that mechanical refrigeration is only a little over half a century old, and that the first successful refrigerating compressor was designed by Dr. Carl Linde in 1873.

At about the same period carbon dioxide was seriously considered as a desirable agent for mechanical refrigeration work. The first $CO_2$ compressor was designed by Doctor Windhausen, about 1880. This particular design is at present only of historical value, indicating as it does, that the handling of a gas at high pressure was quite a difficult undertaking at that time. It operated with a glycerin piston in a second or gas compression cylinder, whereby the use of a stuffing box was avoided. However, it did not work long with any considerable degree of efficiency, because part of the glycerin was discharged with the gas at each compression stroke. The clearance space above the glycerin increased, therefore, continuously, and before very long the machine did no work at all.

The next machines were of the vertical single-acting, crosshead type, with a regular stuffing box, lubricated and sealed by means of glycerin. A machine of this type formed the basis of the well-known J. & E. Hall compressors.

Horizontal double-acting compressors constituted the next step in the development. Some had internally cooled pistons and piston rods, and all these early machines were provided with means for mechanically lubricating and sealing the stuffing box.

The first carbon-dioxide refrigerating machines of the Windhausen type built in the United States were produced about 1890, in the shop of Howard Cochran, Louisville, Ky. In 1897, the manufacture of vertical and horizontal carbon-dioxide refrigerating machines was

*Abstract of paper read before the Milwaukee Engineering Society, Milwaukee, Wis.

# REFRIGERATION *Equipment and Operation*

taken up by the Kroeschell Brothers, of Chicago, who organized a small company for that purpose. This was the successful beginning of carbon-dioxide refrigeration in America. It since has grown from small beginnings to considerable proportions.

A typical horizontal double-acting compressor designed by the author, with valves placed in safety pockets, has been built by the American Carbonic Machinery Company since 1908.

Nearly all of the European carbon-dioxide compressors are designed along standard lines, either horizontal or vertical, single or double acting. Condensers, valves and other auxiliary parts show little deviation from the conventional forms, except that a few years ago Plank suggested the use of an auxiliary compressor connected in tandem to the main piston of the machine, whereby the capacity in output, as well as the economy in performance, was, to some extent, increased.

With the increase in the turning speed of compressor and the advent of synchronous motors as well as other high-speed prime movers, an entirely new design, patterned in principle after the inclosed vertical single-acting ammonia compressor, made its appearance.

Foundry practice, aided by advanced metallurgy and micro-photography, had produced a homogeneous and close-grained casting, which easily withstood the pressure strain of carbon-dioxide compressors. Manufacturers found it perfectly safe to rely on these castings, even though crankcase pressures run at times up to and over the 500 lb. mark.

This practice has established two distinct types of fully inclosed crankcase machines. They may be distinguished by their principal difference in design, as the "step piston" and the "straight piston" type. The step piston machine has the advantage that the entire piston, with connecting rod attached, may be introduced into the machine through the large frame bore from the top. The use of a cylinder sleeve may ordinarily be termed an advantage, since a scored cylinder surface will require only the removal of the particular sleeve.

But it has also many disadvantages. Considering that the cylinder sleeve is hung, rather than pressed, into the bore of the column, it is easily possible that its vertical axis becomes out of line with the identical axis of the column. It can be easily realized that only a very slight digression from the main axis of the machine will produce much binding friction on the part of the step piston. The suction gas entering this machine is subjected to much internal heating, since it is obliged to follow the reciprocating action of the crosshead, during which it comes in contact with the entire guiding surface, picking up not only heat, but also the oil adhering to the latter, all of which is then carried into the compressor cylinder volume.

It must also be considered a disadvantage that these step pistons have considerable weight; therefore, the inevitable inertia at the reversal of the piston stroke is a problem that requires considerable skill in its solution.

In direct distinction from the foregoing, it can be said that the straight-piston type successfully avoids the objectionable features pointed out. The pistons represent a straight barrel. They are light in weight and offer little difficulty as far as their inertia is concerned. The suction gas enters the trunk of the piston directly, and passes through the suction valve into the cylinder volume without any heat increase, except that which it abstracts in the piston and from the cylinder wall.

All moving parts at the lower end of the piston, such as the connecting rod with pin, are located within the crankcase and below the cylinder bore. The lubricating method is simple, and oil cannot possibly be carried over into the flow of gas. In fact, an extra auxiliary pump is provided for the lubrication of the piston at its upper end.

The carbonic compressors of today, and particularly of this type, are provided with two suction ports for dual operation with two different suction pressures. This development has been brought about by the need of liquid cooling with the carbon-dioxide method of refrigeration.

Liquid cooling is accomplished by partial evaporation of the liquid in a separate intermediate receiver. Liquid cooling occurs upon dropping the condenser pressure to that adjusted in the intermediate receiver. The liquid temperature immediately drops to that corresponding with the receiver pressure, while the vapor liberated from the liquid due to the change in temperature, returns directly to the compressor through the high-pressure suction port.

This development in carbonic refrigeration practice is of tremendous importance, since it is the means of greatly increasing the capacity of a machine based on cylinder volume, required in single effect practice. In addition, it produces a considerable reduction in the horsepower per ton.

Various other methods, previously suggested by Windhausen, Linde, and, more recently, by Professor Lamb of England, all have the purpose of increasing the machine output by reducing the temperature of the liquid before it reaches the expansion valve.

The simplest and most effective method is the use of one compressor volume, which fills first with low-pressure suction gas from the evaporator, and at the end of the stroke, with high-pressure suction gas coming directly from the intermediate receiver.

In this way the capacity may be increased as high as 60 per cent, while a reduction in the horsepower per ton up to 20 per cent at certain operating conditions, is a possibility.

Carbon-dioxide condensers are of more than usual consequence and importance in the operating cycle of this system, since liquid temperatures at the outlet from the condenser should be sub-cooled to lower than the overflow water temperature, which is easily possible by selecting the most effective condenser type.

In the proper use of the dual compression system it is necessary to use automatic valves, so that the best effect may be constantly and continuously obtained in practice. When such operation is left to manual interference, the best effects are often destroyed by lack of understanding on the part of the operator. Automatic means have since been developed, which assume the function of control without manual assistance, and thereby produce economical results continuously.

# EDITORIALS

## Twenty Years' Advance in Marine Practice

THE proposition to recondition the Shipping Board steamers "Mt. Vernon" and "Monticello" draws attention to the marked advances made in the machinery of ship propulsion during the last twenty years. These vessels, as the crack German liners, "Kronprinzessin Cecile" and the "Kaiser Wilhelm II" were launched nearly twenty years ago and for several years held the blue ribbon of the Atlantic. They had coal-fired boilers and quadruple-expansion engines.

Under the reconditioning plans proposed, new oil-fired boilers and geared turbines would be installed. The machinery weight would be reduced from seven thousand to three thousand tons, with a corresponding saving in space of thirty-three per cent. Most striking of all is the estimated reduction in operating personnel, from three hundred and sixty to sixty-five men, due largely to eliminating coal passers and firemen.

The large reduction in machinery weights would make it possible for these vessels to carry not only enough fuel oil for the return trip, but also an excess sufficient to supply the "Leviathan" with fuel for its return voyage. At present this oil must be purchased abroad at an advance of $270,000 per year over domestic cost. The reduction in space and weight expressed in increased earning capacity, the saving in labor and the increased operating economy, in the aggregate, explain why such ships soon become obsolete.

There are, of course, other reasons advanced for reconditioning these ships. They are needed to supplement the "Leviathan" and round out a weekly sailing schedule. The hulls are reported in excellent condition, and the total estimated expenditure of about twelve million would be returned to American industry.

## Total Power Costs

CERTAIN phases of the organization of our electrical utilities are now being investigated by the Federal Trade Commission. Regardless of the results of the present inquiry, one can expect continuing attacks on the utilities, largely for political purposes, in much the same way that the railroads were hounded twenty years ago. It is possible, however, that the net result of such campaigns may have some indirect influence on power plant design and operation.

The result of scrutiny of expenditures will direct attention to total costs of generating power. Engineers have given close study to gains in thermal efficiency in planning for load growth and station extensions. Have they given equal attention to total costs of power in these cases? One sometimes wonders whether all that is possible has been developed from old plants. Some old stations may warrant considerable rehabilitation for peak-load service. Many utilities have made no attempt to interconnect with privately owned plants which at times have excess power that could be utilized and distributed by the central utility. There is also the possibility of developing money-making byproduct processes in connection with the central station, such as the sale of high- and low-pressure steam, the development of cinder-block plants to use the refuse, and off-peak processes to build up load factor.

Should the agitations over our electric supplies lead to demands for lower rates, then if these companies would continue to enjoy their present rates of profit, every expenditure must be carefully scrutinized and assurances must be at hand that the costs of power are the lowest possibly attainable. Our engineers can save themselves much work later on by giving thought to some of these factors in their plans for future extensions.

## Making *Power* Work for You

A SUBSCRIBER recently wrote, telling how he was using certain editorials published in *Power* to influence the factory management to make changes that improved the use of power in his plant. He referred to the series of editorials that have been published from time to time, entitled, "Imagine the Savings!"

It has been this correspondent's practice to clip these editorials and send them to his factory manager, with appropriate comments showing how the opportunity for improved practice and waste avoidance pointed out in the editorial existed in their plant. This has proved productive of results. Equipment changes have been made, and certain service and maintenance work has been shifted from other departments to that of the power engineer. The net result is what might be expected—a lower cost of power in the finished products of the plant.

This procedure has served another purpose—one which those directly concerned, even this correspondent, may not yet have noted. It has strengthened the power engineer's position in the plant and has helped to increase his authority and relative standing more nearly to that to which the importance of his duties—supplying the plant

with the means of functioning—entitles him. *Power* believes that the greatest factor in American prosperity is the comparatively great use of power, and that only as this use grows, in both magnitude and economy, can this prosperity continue to increase. And growth in economy in the use of power can best be promoted by increasing the field of activity of power engineers to cover the application of power services.

Making use of *Power* in this manner is possible for many other power engineers. Perhaps the particular series of editorials here mentioned will not serve everyone's purposes, but the contents of any issue is broad and varied. Almost any power engineer, in almost any issue, can find something that he can bring to the attention of other executives in the plant, with advantage both to the plant and to himself.

## Safety Factor in Condemning Elevator Cables

WHEN to condemn elevator cables is one of those questions comparable with "How old is Ann?" A rule applied by many is to condemn the cables when they show five or six broken wires in one strand in about one foot length. This rule must be applied with considerable judgment, as there are other factors that affect the condition of elevator cables besides broken wires.

Considerable attention has been given to devising some better method of judging the condition of wire rope than the number of broken wires, but none has been developed to a practical state, although several have been experimented with.

Extensive tests have been made on wire rope, both new and after it has been condemned and removed from elevators, to determine to what extent its strength is affected by broken wires. Tests on new rope show a fairly consistent relation between the per cent reduction of metal area due to broken wires and the per cent reduction in the original strength.

Tests on cables removed from traction elevators after being condemned on account of broken wires, show no relation whatsoever between reduction in metal area and reduction of original strength. In one case, with ten wires broken in a three-foot section and a reduction of twelve per cent in metal due to wear, the breaking strength was greater than that for the cable when new. This cable had a record of nearly twenty-two thousand miles. Another test on a three-foot section that had over two hundred breaks in its one hundred and fourteen wires, developed a breaking strength of nearly eleven thousand pounds, when the original breaking strength as given by the manufacturer was twelve thousand pounds. This cable had been in use for nearly forty thousand car miles.

The high test strength that has been found in cables that have been condemned, and the factor of safety of about twenty-five existing in new cables on traction machines have led to the opinion among engineers that perhaps elevator cables are frequently condemned before they should be. It is argued that these cables, when they are condemned, may have a safety factor more than twice that required by law. This is a fact, but not infrequently cables have suddenly gone to pieces and broken when they appeared to be in fairly good condition and had been passed by the inspector. This has happened with governor cables the same as it has with the hoisting cables. These experiences would lead to the opinion that there is an element of danger even in the apparently conservative method that is now used in condemning elevator cables.

A cable's strength, as determined by a straight pull in a testing machine, is probably much higher than exists under the conditions in service. In the latter the bending stresses may destroy the cable in a short time even if in a test machine it developed a large part of its original strength. Until it is possible to know more about the action of elevator cables under actual working conditions, it is little use to attempt to apply test-machine results as a means of determining when they should be condemned. It is better to remove the cables a little too soon and be safe than not soon enough and have an accident.

## Imagine the Savings!

IMAGINE what a difference it would in the power consumption of some industrial plants, and therefore in the cost of power in the finished products, if the motive power for the production machinery was always applied and utilized with the same economy and efficiency as motive power for the generators and auxiliaries in the power plant. Unfortunately, there are some production departments that seem to think that as long as a machine produces at the desired rate, nothing further need be required. How much power is being wasted and at what higher rate of production the machines might operate, they do not know or care.

While such production departments are becoming rare, where they do exist a change should be made. The remedy for these troubles is to place the oversight of power application and utilization under the power engineer, who understands what power economy and efficiency are and how to obtain them. Where given the authority, the power engineer quickly eliminates these wastes.

And, if the management realized the reduction in cost of power in the finished product that the power engineer can make, how quickly they would call on his services. It is the managements that do not realize this who experience these wastes. But, when they do see the losses incurred and take the necessary steps to avoid them, imagine the savings that will be made!

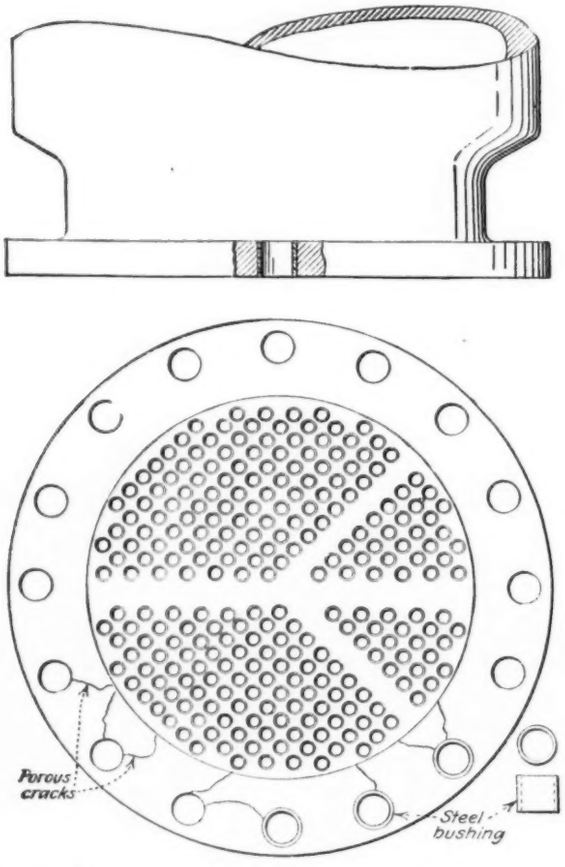
# IDEAS *from* PRACTICAL MEN

*Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted*

## A Practical Method of Making Leaky Porous Flanges Tight

RECENTLY, a large feed heater serving three high-pressure boilers, developed a serious leak, necessitating bypassing the feed and cutting out the heater.

The heater was an exceptionally large one, weighing




*Steel bushings expanded in bolt holes stopped leakage through porous cracks in flange*

8,630 lb. empty. The lower head was removed and the flange thoroughly cleaned, a new gasket put on and the head tightened in place. Then a hydrostatic pressure of 250 lb. was applied and the joint leaked as badly as ever. The head was taken down several times and different kinds of packing were tried without results. In the meantime cold water was being supplied to the boilers. Two days had been wasted and it looked rather dubious.

Finally, one of the engineers stated that he thought the heater was weak and the pressure was causing it to give. This prompted us to make a close inspection of the flange, and upon doing so we discovered faint scratch marks which proved to be porous and were communicating the water end with the stud holes. As it would be practically impossible to close the cracks by welding, the following method of repair was adopted: Eight defective holes were enlarged one-eighth of an inch in diameter, and steel bushings were rolled in them the same as a boiler tube. When the head was again put in place and a hydrostatic pressure of 500 lb. applied, not a sign of a leak showed up.

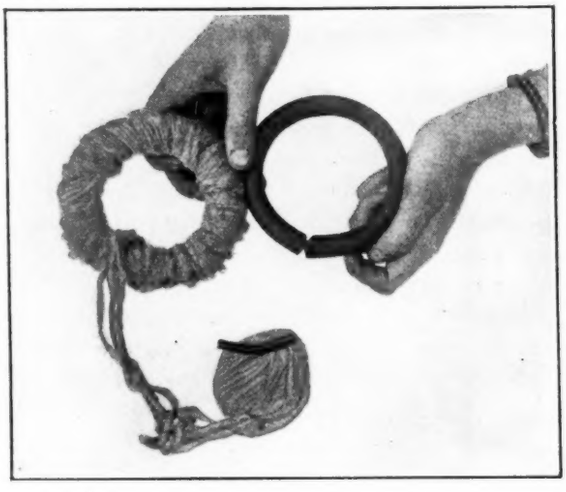
The heater has been in operation now for nearly two months.

EARLE S. NASON.

Boston, Mass.

## Large Piston-Rod Swabs Neatly Made

SOME time ago I needed some large piston-rod swabs and had nothing conveniently at hand to make them out of. Some short pieces of old oxygen hose were cut off and the ends forced over a short piece of round iron



*Swabs made from oxygen hose and wicking*

bent to the proper radius, which held the ends firmly together, the thick, small hose affording a perfect frame.

Wound with the usual wicking, they made neat swabs, easy to make, apply and remove when necessary.

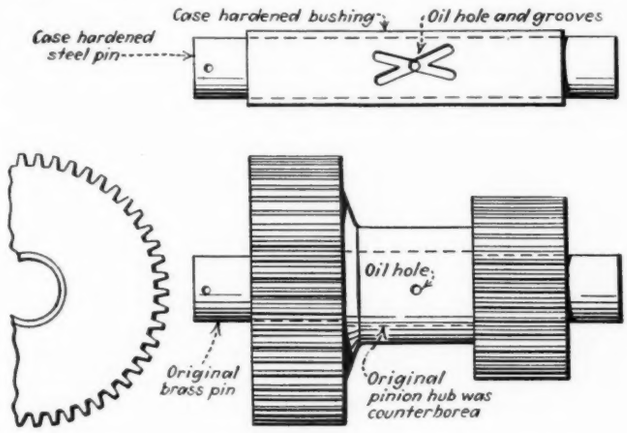
Missouri Valley, Iowa.

FRANK BENTLY.

## Improved Bushing for Stoker Pinion

IN THE operation of some stokers using planetary gears, we experienced trouble with a shaft on which one of the pinions turned.

As shown in the accompanying sketch, the two pinions were formed on one blank and ran in mesh with the outside ring gears. The shaft on which they turned was originally of brass and was pinned to the housing so




*Original and improved shaft for stoker pinion*

that the pinion ran on a stationary shaft, which consequently wore on one side only. This wear allowed the pinion to back out of proper mesh, causing the teeth to break.

We tried a number of different methods of remedying this trouble, such as additional oil grooves and harder pins, but the method that proved most successful and the one we finally adopted was the following: A pin was turned up out of steel and casehardened. We then took the pinion and turned enough out of the bore to allow a bushing to be fitted which would be a running fit on the pin. This we also made up and casehardened, drilling oil holes and grooves so that adequate lubrication was assured. R. G. EDWARDS.

Port Arthur, Ont., Canada.

## Shortage of Water Caused by Dirty Waterworks Condenser

THE recent overhauling of a pumping station revealed an unsuspected cause of trouble.

Water is obtained from artesian wells and a shortage of water necessitated cleaning out the wells. After the cleaning, the supply was increased, but not sufficiently for the capacity of the pump. If the pump was run at full speed, it would pound owing to insufficient water. Thinking that the supply was failing, it was decided to drive more wells.

While waiting for the well-drilling machinery, it was decided to overhaul the condenser and remove several split tubes. The condenser was the standard waterworks type connected directly to the suction of the pump, so that the water from the wells flowed around the outside of the tubes. It contained 300 tubes, $\frac{3}{4}$ in. in diameter by $6\frac{1}{2}$ ft. long, and the shell measured 42 in. in diameter.

Opening up the plates on the ends of the condenser disclosed about fifty leaking tubes. After marking the leaky ones a punch was made to drive them out. This was how we located the trouble. It was impossible to drive the tubes out. We opened up the manhole plate on top of the condenser and on inspection found the bank of tubes one solid mass of mud. It was practically impossible for any water to circulate around the tubes. The tube bank cleared the shell by about 4 in. and this was the only passage the water had.

We tried washing the mud away with a hose, but this moved but a small quantity near the outside. It was finally decided to bring the whole bank of tubes upon the engine-room floor. Even after getting the tubes on the floor it was found that it would take considerable time to remove the mud and properly clean the tubes, so we decided to cut them out, both good and bad. It took two men two days to cut the tubes out and prepare the sheets for the new tubes.

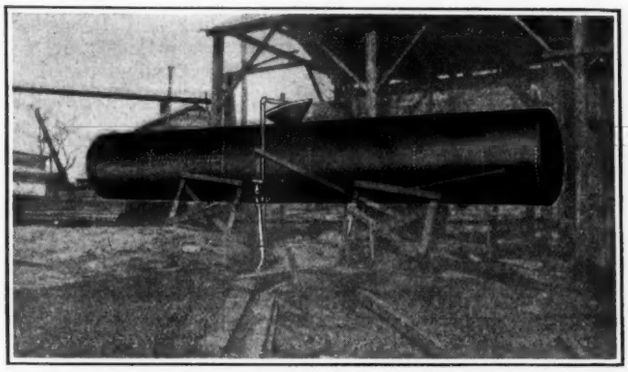
Putting the tubes in was a simple matter, and after finishing packing them, we started the pump. At the fastest speed the pump obtained plenty of water and it was decided not to drive more wells, thereby saving a considerable sum of money. JOSEPH O'BRIEN.

Rosedale, L. I., N. Y.

## Old Boiler Used as Water Storage Tank for Fire Protection

THE illustration shows how an old steam boiler has been arranged for use in combating fires that break out in a small manufacturing plant, by putting pressure on the water in it with steam from the plant's boilers.

The old boiler is mounted in timber saddles beside the plant boilers, and is connected to them by a 3-in. steam line with a gate valve at the boiler. A 1-in. water line is connected at the top for keeping the boiler filled



*When pressure is needed, steam from the plant is turned into the boiler above the water level*

with water and a 3-in. pressure header is connected to the bottom and carried through the plant.

The old boiler is kept almost full of water at all times. When fire breaks out in the plant, the valve in the steam line is opened wide, turning steam pressure into the boiler above the water. Then the valve in the line leading to the plant is opened, turning the water under pressure through the line. L. M. JORDAN.

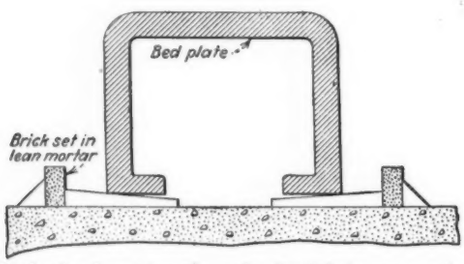
Cairo, Ga.

# COMMENTS *from* READERS

## *Grouting Machine Bedplates to Their Foundations*

THE article "Grouting vs. Bedding Machinery," in the Jan. 10 issue, brings up a very old as well as a much-discussed subject. Grouting and bedding machinery are synonymous terms and mean the same thing when the job is finished; namely, uniting the machine with its foundation.

It is first necessary to level and line the machine up. The leveling is done with iron on hardwood wedges to support the machine one or two inches above the foundation. When this is done, the space between the machine's base and its foundation is filled with some material that will flow into place and then solidify to form a bond between the foundation and the bedplate of the machine. Reciprocating machines will require a better bond with




*Method of supporting the bedplate on wedges*

their foundations than rotating machines, such as converters and motor-generator sets.

Sulphur has been used to bond machine bedplates to their foundations. This method is obsolete, because of the danger in melting and pouring the sulphur, and also because it has a tendency to crack when under pressure. When the space between the bedplate and foundation is thin, fine cast-iron filings and sal ammoniac have been used.

Cement and sand are the predominating materials. How these should be mixed and the proportions of each brings up a much disputed question. Some erectors use a mixture of equal parts of cement and sand and mix this with water to form a stiff mortar. This mortar is packed tightly under the bedplate. I have found that such a mixture will crack and crumble and allow the machine to get out of alignment.

For grout I use two parts of cement to one of sand and mix with water to give a thin consistency. The more it is mixed the better the grout will set, unless the batch is allowed to stand so long that it begins to set before running into place.

The method of applying grout in this form is simple. Build a dam around the outside of the bedplate, as indicated in the figure, making the height above that desired for the grout. Then pour the grout, which should be thin enough to seek its own level. Grout mixed in this way will flow into the openings, and puddling is necessary to remove the air only. If there are holes in the bedplate, then this will not be necessary. If the mixture is made with a greater proportion of sand than cement, it will not flow properly and no amount of puddling will make a good job.

B. M. ADAMS.

Pittsburgh, Pa.

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## *Preventing and Extinguishing Fires*

THE opinion seems to be general that a small amount of water used to extinguish a fire may actually increase the combustion because of the breaking up of the water into its chemical elements, hydrogen and oxygen. This opinion was expressed by a reader of *Power* in the Jan. 10 issue and is frequently mentioned in connection with important conflagrations.

In my opinion these statements are a direct contradiction of the law of conservation of energy. If we can build a fire, throw water on it, and thereby secure more fuel to further support the fire, we are getting something for nothing, which common experience indicates is impossible.

The chemist tells us that $2H_2 + O_2 = 2H_2O$ and that this reaction is accompanied by the development of a large amount of heat. The oxy-hydrogen blowpipe is an example of this.

The chemists further tell us that water, $H_2O$, can be separated into its elements if the necessary amount of energy is supplied. The electrolytic dissociation of water is a familiar example of this. Isn't it fairly obvious that the amount of energy liberated by the combination (burning) of hydrogen and oxygen in the proper proportions is just equal to the amount of energy required to produces these gases from the water?

A pound of pure carbon ignited with the theoretical amount of air produces 12.52 lb. of gas and liberates approximately 14,600 B.t.u. of heat. This gas is carbon dioxide and nitrogen and will roughly have a specific heat of 0.25, although this value changes with the temperature. Assuming that no heat is lost during the burning, the temperature will be $\frac{14{,}600}{(12.52)\ (0.25)} = 4{,}650$ deg. F. above the initial temperature.

Now suppose that we introduce one pound of water into the fire. The water must be raised to the boiling point, must absorb the necessary latent heat to become steam, and then be superheated to the final temperature. Estimating the specific heat of superheated steam at atmospheric pressure as 0.5, our final temperature can be found as follows:

$$14{,}600 = (12.52)\ (0.25)\ (T) + (1)\ [212 - 60 + 970 + (T - 212)\ (0.5)]$$

$T = 3{,}740$ deg., which is lower than before the water was introduced.

We know that the pound of steam in this reaction will contain 0.11 lb. of hydrogen, and using the customary heat value of hydrogen, this will introduce 6,900 B.t.u. into our combustion provided the dissociation of the steam does not require any energy. My version is that the energy required to break up the water molecule is just equal to the energy received by reason of the union of the hydrogen and oxygen molecules and that the combustion is chemically unchanged because of the water introduced, although the temperature is reduced because of the greater heat content and the absorption of latent heat.

I appreciate that conditions may arise where the introduction of a small amount of water on to a fire may produce steam in places where its expansion may mechanically agitate the burning material and expose fresh fuel to the flames. Perhaps some of *Power's* readers can give further light on this point. ELMER S. SMALL.

Oak Park, Ill.

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## *Providence as an Assistant Engineer*

THERE were several of us old timers in the smoking compartment out of Buffalo the other night, and as is always the case when men of the craft get together, the talk turned to shop. One man, a boiler inspector, remarked that he had read in *Power* of the experiences one inspector had with engineers leaving the chokes on pop valves, and related one or two instances in his own experience where the same thing had happened.

"Well," spoke up one old veteran, "you will hardly see any of those things in a modern up-to-date plant of today, but some forty years ago it was a different story. To put a nigger on the safety valve was almost a habit with steamboat engineers, and in many stationary plants the engineer would tie all the scrap iron he had around the plant on the valve, in the effort to prevent it leaking.

"In those days I was a rolling stone; I did not gather much moss, but I certainly saw a good deal of the kindness of Providence toward the men handling steam plants. I had a job to repair some cotton gins one time," he continued in a reminiscent strain. "The plant was near a certain Southern city of national fame on account of a famous retreat Uncle Sam has located there. When I arrived, the owner was not around, so I strolled over to the plant. The first place I hit was the boiler room. The boiler, one of the locomotive type, was of about 75 hp., fired with wood. Steam was up and the engine, a side-crank, was humming and the gins were buzzing away. Looking around, I could not see any steam gage, nor could I locate any water gages; the water column was there, but the glass was broken out and the try-cocks had been plugged up. Just then a man came running down the steps, threw in a few sticks of wood, put on the injector and, seeing me, nodded a greeting.

"Explaining my business, I asked where he kept his steam and water gages. Pulling out a plug of Brown Mule tobacco, he bit off a good-sized chunk, spat on the boiler front and said, 'What in thunder do I want them things for? I fire up and when the engine sorter slows up, I know the steam is getting low. That leak that you see over about halfway on the side shows me how much water I have. I put on the injector until I see water spitting out there, then I shut it off, and I know just about how long it will run without putting in any more. You got to have brains and judgment to handle these things, young man.' Saying which, he ran upstairs again to the gins.

"I decided about then that I did not want any job repairing gins around that plant and left without seeing the boss. Some time later I was told that the boiler in that plant had exploded and the experts could not fix a cause for it. Yes, Providence certainly took a hand in the operation of plants in those days, and in some that I have seen lately I am of the opinion that the same Providence is on the job." THOMAS M. STREET.

Wilkes-Barre, Pa.

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## *Wrong Coil Pitch Caused Slow Speed of Motor*

WHILE looking through some copies of *Power,* I ran across an article on page 784 in the Nov. 22, 1927, issue by George Richter, entitled "Wrong Coil-Lead Pitch Caused High Motor Speed." This was extremely interesting to me, as a similar case had come to my attention, which concerned the rotor of a standard make of alternating-current motor of the single-phase repulsion induction type, with a device for short-circuiting the commutator segments at full speed.

In Mr. Richter's problem the armature ran at high speed in an effort to generate the required counter-electromotive force, but in my problem the rotor could not come up to full speed. The motor had been repaired and was in a local shop when I happened in to read the meters. I joined in the few tests that we could make and found that the entire winding job was neatly done The stator coils tested O.K. and were connected properly. The rotor winding was well done and showed up properly when a bar-to-bar test was made, and apparently was not at fault. The machine was sent to a repair shop operated by one of the large electric manufacturing companies and they, too, failed to find the trouble.

It finally developed that the local repair man had failed to gather sufficient data before tearing the job down to rewind the machine properly. For this reason an error was made in the coil pitch. When a print of the correct winding connections was secured from the manufacturers of the machine and the corrections made accordingly, the machine went into service satisfactorily. This is another instance that emphasizes the necessity of making a careful record of a winding connection before taking the coils out of the slots. HENRY MULFORD.

Patchogue, N. Y.

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## *Burning Natural Gas in Small Combustion Space*

IN THE Dec. 27, 1927, issue C. W. Stevens requested suggestions on the type of burners to use and the proper methods of burning natural gas efficiently in a Scotch-type two-pass boiler designed for coal burning.

A burner designed for efficient operation, in connection with the small combustion space, which is a characteristic of the Scotch boiler, should provide for an intimate mixture of the gas and primary air so that the maximum rapidity of combustion of the gas may be attained without having a considerable amount of excess air present, and at the same time maximum flame temperatures developed with a short flame.

Since the gas pressure available is low, being only 5 in. of water, a mixture-compressed system would no doubt meet all the foregoing requirements for this particular installation. This system consists of a high-speed, volume-type fan, direct connected to a motor drive, and a double valve which controls both air and gas at the same time. The blower draws air from the atmosphere and gas from the supply line, at low pressure, into the fan casing, where they are well mixed, then forced by the fan through a suitable burner nozzle into the furnace. This equipment has all the advantages of the high-pressure burner and does not require a high-pressure source of supply.

An atmospheric burner of any good type may be used on this boiler with good results if the combustion space is increased. This may be accomplished by removing the grates and the present front end of the furnace and building a Dutch oven of sheet iron, lined with a suitable refractory. The size of the additional combustion space will be governed by present space available, rate at which the boiler is to be worked, and the burner selected. The burner should be located as near the floor of the oven as possible without the danger of having the flame strike the floor. A checker wall of good firebrick, built about four or five feet inside the furnace from the face of the burner, may be necessary to obtain good combustion with some types of atmospheric burners. The purpose of this checker wall is to act as an igniter for the gas and to break up the flame, to eliminate stratification and its evil effects.

Additional data, such as cubic feet of combustion space, and the proposed rating at which the boiler is to be operated, would have allowed more detailed and specific suggestions.

M. S. FITZWILLIAM, Chief Engineer,
Arsenal Hill Station, Southwestern Gas & Electric Co.
Shreveport, La.

## Answers to What Do You Know

*The questions are on page 510*

Ans. 1—The crank is at a point such that the crank arm makes an angle of less than 90 deg. with the engine's line of centers on the forward stroke, and on the return stroke the crank makes the same angle with the line of centers as measured from the head dead center. The exact positions of the points depend upon the crank-to-rod ratio.

Ans. 2—Down to a certain point depending upon the design, the efficiency of the engine depends upon the number of expansions made by the steam in the cylinder, or a short cutoff is better than a long cutoff. To obtain a short cutoff with any single valve the steam lap must be long. As a consequence the area of the *D* valve exposed to boiler pressure is so great that the frictional resistance becomes too high for satisfactory operation. As a result *D* valves are limited to a minimum cutoff of $\frac{5}{8}$, although in some cases a cutoff of $\frac{1}{2}$ has been used. The long cutoff precludes the efficient use of the steam, while a balanced valve can be designed to give short cutoffs.

Ans. 3—A mixed-pressure turbine may be said to consist of a high-pressure condensing unit with an extra large low-pressure end so arranged that steam at a lower pressure is fed into the lower stage when it expands along with the steam coming from the high-pressure end. Usually, high-pressure steam is used only when there is insufficient low-pressure steam entering the turbine.

Ans. 4—The weight of the air may be found by the formula $PV = MRT$, when $P$ is the absolute pressure per square foot, $V$ is the volume in cubic feet, $M$ is the weight of air in pounds, $T$ the absolute temperature, or 460 + deg. F., and $R$ a constant which for air is approximately 53.2. Substituting the correct values, we have

$$144(100 + 14.7) \times 0.7854 \times 5^2 \times 20 = M \times 53.2(460 + 60), \text{ or } M = 238 \text{ lb.}$$

Adding the weight of the tank metal, the total weight on the skids becomes 13,238 pounds.

Ans. 5—When steel is heated to a high temperature and allowed to cool slowly, it passes through three transformations in which the character of the crystals is changed. At a high temperature the steel settles in thermal equilibrium with a certain crystalline structure. If the chisel is suddenly cooled, it does not have time to go through the transformation mentioned, so the crystalline structure that exists at the high temperature is left in existence at ordinary temperatures. This structure is so brittle that it is necessary to change the structure slightly by heating and allowing the chisel to cool.

Ans. 6—A pump for fire protection must have large valve areas and other special features. About 27 years ago John R. Freeman analyzed the situation and listed a number of features a fire pump should possess. The specifications were adopted by the National Board of Fire Underwriters, and the pumps for fire protection of policy holders must conform to the requirements.

Ans. 7—The logarithm of a number is the power to which 10 must be raised to equal the number. For example the log of 100 is 2, since $10^2 = 100$, and the log of 2 is 0.301, since $10^{0.301} = 2$. Log tables permit one to find the log of any number; the advantage of logs is that to multiply two large numbers it is only necessary to add the logs of the number and then find in the table a corresponding number, which will be the product of the original two numbers. Other and more complex mathematical processes are easily carried on by the use of logs.

Ans. 8—The intent of Par. P-293 of the Code is that the shutoff valve in a connection to a water column shall not only be of the through-blow type so as to prevent the accumulation of scale and sediment, but also be of such a type of construction that the operating mechanism will show by its position whether it is open or closed, and can be locked in open position. If the construction of the valves referred to is such that it will meet the two requirements, it will meet the intent of the rule.

Ans. 9—By a rearrangement of the motors so that they will be more nearly fully loaded; by replacing some of the large motors with synchronous motors; where the motors are of small size, some of them may be replaced by the synchronous induction type; by the use of synchronous condensers or by the installation of static condensers.

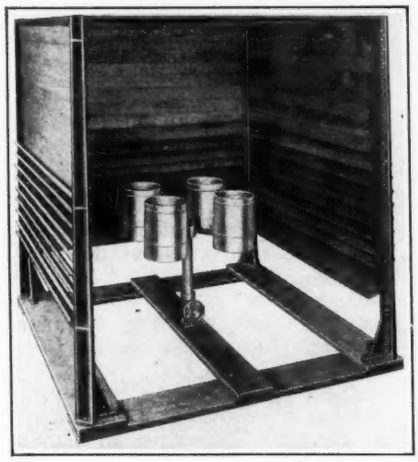
Ans. 10—The gear *A* moves anti-clockwise, so that the water is drawn up along the outer casing by both gears and then is forced out of the pump by the meshing of the teeth at the center.

# *New and Improved* EQUIPMENT

## Marley Unit Type Spray Cooling Tower

A SPRAY cooling tower particularly adapted to ice-plant, oil-engine and similar installations, where small quantities of water must be cooled continuously, has been brought out by the Power Plant Equipment Company, of Kansas City, Mo.

The tower when assembled occupies an area of 8x8 ft., is 9 ft. tall and will cool any quantity of water up to 100 gal. per min. The main support frame if of cast iron slotted to hold louver boards without nails or other fasteners. The spray equipment consists of four Marley cooling cones assembled upon



*Marley unit type spray cooling tower with louver boards on one side removed to show interior*

a special group fitting. Each cone is made up of a standard open type nozzle within an open cylinder. This tube or cylinder is mounted on the nozzle and is concentric with it. When the nozzle operates, the upward flow of water induces an inward and upward flow of air through the cylinder, thus improving circulation of air within the tower and insuring more thorough cooling. The capacity of any tower is readily varied to suit installation requirements by a change of nozzle size.

The tower comes as a complete unit ready for operation. Its installation is easy, as it occupies comparatively small space and no anchoring is required. If desired, the tower may be readily mounted above a collecting basin or water storage reservoir.

## Griscom-Russell Heat Exchanger for Corrosive Liquids

A TYPE of heat exchanger developed especially for handling dirty or corrosive liquids has been brought out recently by the Griscom-Russell Company, 285 Madison Ave., New York City.

The exchanger, which is known as the G-R Tubeflo, is made entirely of semi-steel. The fluid passages are straight, smooth, cored holes. The main portion of a section unit, as shown in Fig. 2, consists of a number of body pieces which are bolted together to make up the required length for a desired cooling effect. At one end of the section is bolted a stationary head which contains the inlet and outlet connections, together with the necessary partitions for directing the flow of the fluids through the four chambers of the body pieces. At the opposite end of the section a floating bonnet forms a crossover connection between the passages. The stationary head is also provided with a removable cover which permits easy inspection of the chambers and accessibility for cleaning.

The various parts are all standard and interchangeable. Sections are readily made longer or shorter by changing the number of body pieces; they can be installed in stacks one over another; and any number of stacks can be used in parallel, depending upon the duty which they are to handle. When arranged in stacks, the stationary heads of the sections are bolted together, and the body pieces of each section are held in proper position by lugs which permit free movement for expansion and contraction. The smooth cored passages not only facilitate cleaning, but permit the use of high velocities of the hot and cold fluids with correspondingly high heat transfer rates.

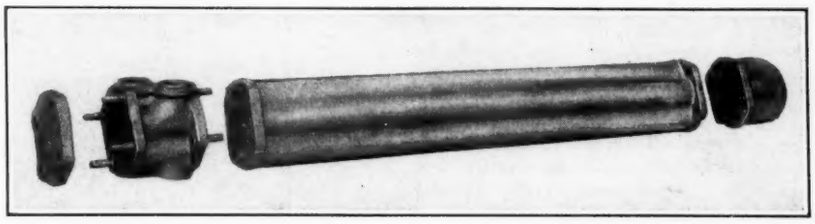


*Fig. 1—View of exchanger body disassembled*

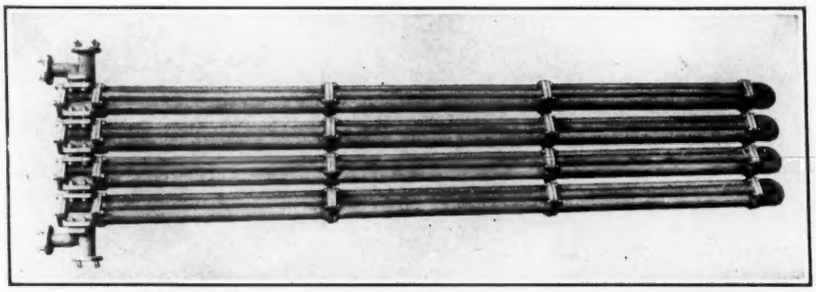


*Fig. 2—Assembly of a number of body pieces*

## Allis-Chalmers Line-Start Induction Motors

A LINE of squirrel-cage induction motors suitable for starting on full-line voltage has been recently introduced into the field by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

These motors are normal-torque, high-reactance machines and will not draw starting current in excess of the standard limits. They are built in sizes from 7½ to 30 hp., 600 to 3,600 r.p.m., for 110, 220 and 440 volts, and are available with either sleeve or roller bearings. A magnetic switch with push-button control is the only starting equipment used.

# Electric Control for Heating Systems

MANY heating systems installed today are sectionalized so that advantage may be taken of the varying amounts of heat required in different parts of a building. In order to realize the full saving that can be obtained with such an installation, the steam supply must be regulated to meet the needs of each particular section. To accomplish this, throttle valves are often placed in the supply mains to each section, and are used to reduce the steam supply to those sections requiring a relatively small amount of heat. To permit centralized control of these remotely located valves, the Webster Talmadge & Company, Inc., 50 Church St., New York City, has developed the electric control equipment shown in Figs. 1 and 2.

Fig. 1 illustrates the front and back of the control board that would be located in the engineer's office. Turning the control handle, for example, to the figure 30 on the dial will so regulate the throttle valve in the supply main to this particular section that only 30 per cent of the normal steam supply will be delivered.

The wheel marked *A*, Fig. 1, turns with the handle and carries with it one of the levers marked *B*, thus winding a coil spring attached to it. The other lever marked *B* is released, allowing a coil spring to unwind an amount determined by the movement of the control handle. The unwinding of this spring causes the escapement *C* to make a definite number of revolutions. In revolving, the posts on the escapement wheel *C* engage with the lever *D* and cause an electric contact to be made. This sends a series of electric impulses to the receiving end of the equipment. The direction of rotation of the control handle determines which of the levers *B* will be released, which in turn determines the direction of rotation of *C*, and which of two electric contacts will be closed.

The receiving end of the equipment is shown in Fig. 2. Each electric impulse sent over the connecting wires energizes one of the two magnet coils seen at the left of the illustration. Each time the coil is energized, it attracts the armature, on the end of which is a pawl. This pawl engages notches in the wheel *D* and moves it around one notch for each electric contact or impulse sent out from the sending instrument. The wheel *D* is moved in either direction, depending upon which coil is energized. The action is such that it takes up a definite position for each position of the controller handle shown in Fig. 1.

On the wheel *D* is formed a cam, on which the cam-follower *E* rolls. The follower *E* is pivoted at *F* and carries at its other end a shaft that operates electrical contacts for either open or close direction of the motor driving the valve-operating mechanism.

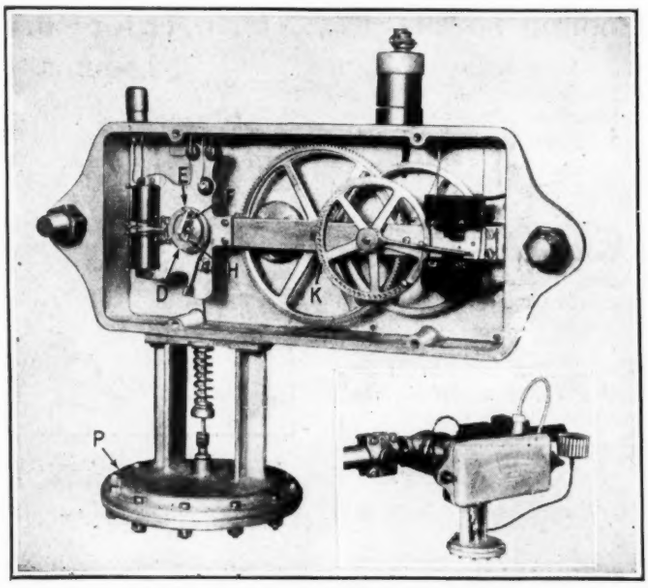



*Fig. 2—Valve-operating mechanism*

The member *H* to which *E* is pivoted rotates separately from the wheel *D*. Its motion is controlled through a rack and gear, by the pressure diaphragm *P*, which is connected to the low-pressure side of the regulating valve, as shown in the insert. Thus the position of cam *D* determines the pressure required on the diaphragm in order to move *H* to such a position that the cam-follower *E* is neutral and both electric contacts are open. An increase in pressure will now cause *H* to move and *E* to drop off the cam, thus closing the starting contact, operating the motor in such a direction that it will close the throttle valve until the required pressure is reached and the cam *E* moved back to its neutral position. The motor is mounted on the back of the controller and operates the valve stem through a series of reducing gears. The gear *K* operates a limit switch, which prevents the motor from injuring the valve. Additional valve protection is provided by a spring clutch installed between the valve stem and driving gear.

The manner in which the controller is installed and assembled on the pipe line is shown in the insert. It is a simple matter to remove the controller when work is to be done on the valve.

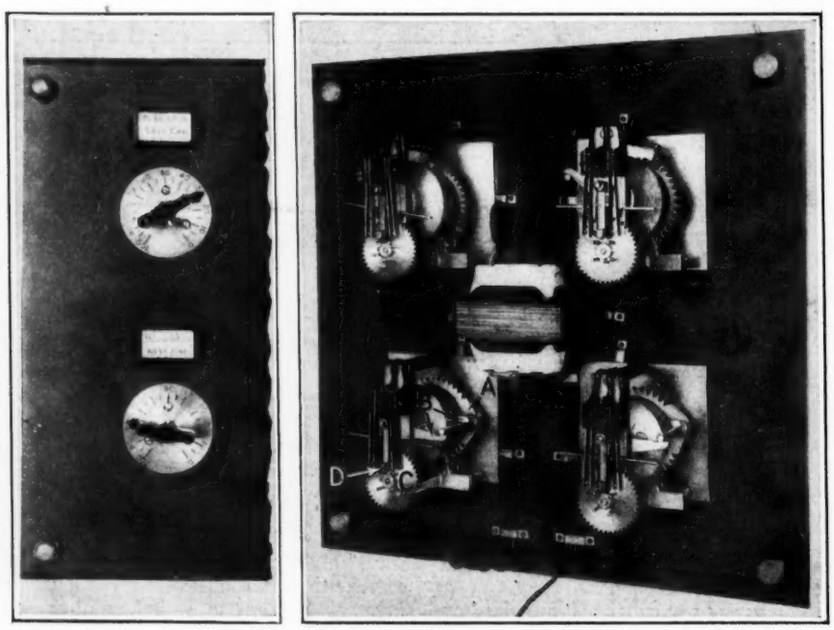
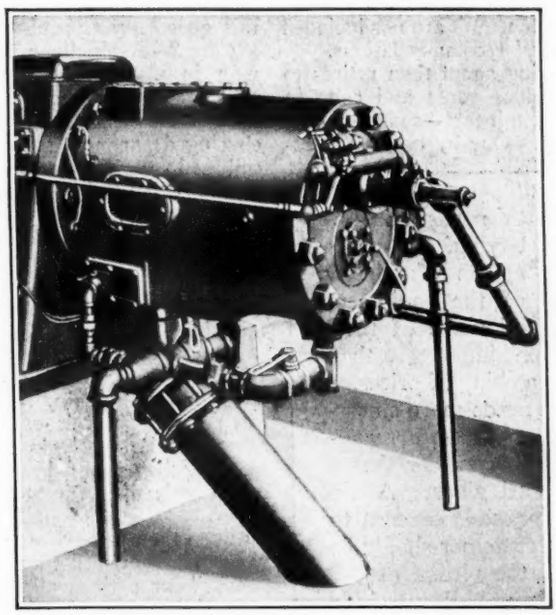



*Fig. 1—Front and rear view of control board*

## Corliss Valve Gear for Two-Stroke-Cycle Gas Engines

A DEVICE for injecting gas under pressure into the cylinder of a two-stroke-cycle gas engine has been developed by the Bessemer Gas Engine Company, Grove City, Pa.

In the usual two-stroke-cycle gas engine the gas charge is inducted into the crank end of the cylinder, where it is mixed into the air charge. When the piston uncovers the exhaust ports, this air-gas mixture blows into the power cylinder through transfer ports and forces the burnt gases from the cylinder as well as supplying the mixture for the next explosion. A certain amount of the air-gas mixture blows out through the exhaust ports along with the spent gases, and as a result the thermal efficiency of such engines is not high.



*The Bessemer Corliss valve gear for gas engines*

The same type of power cylinder is used as in case of the standard two-stroke-cycle engines, but only air is admitted through the inlet ports. This air displaces the gases and leaves the cylinder filled with pure air only at the beginning of the compression stroke.

As soon as the exhaust ports have been closed and there is no chance for fuel to escape, the injector valve in the power cylinder head opens and admits the charge of fuel gas under about fifteen pounds pressure. This valve remains open for a very short time and closes before the compression pressure has been built up to a point equal to that of the injection pressure. As the gas enters the cylinder, it mixes with the air which has been admitted through the inlet port, and at the end of the compression stroke the fuel mixture is complete and uniform. Tests have shown that the fuel consumption with the Bessemer gas economizer is 11 cu.ft. or less per brake horsepower-hour.

The economizer consists of a valve mounted in a suitable cage and placed horizontally in the upper half of the power cylinder head, as shown in the illustration. This valve opens inward into the cylinder. Holding the valve to its seat is a compression spring, and mounted upon the valve stem is a dashpot piston working in a cylinder mounted on the valve cage. There is also a hardened steel collar mounted on the valve stem, which is fitted to a forked lever of the driving mechanism.

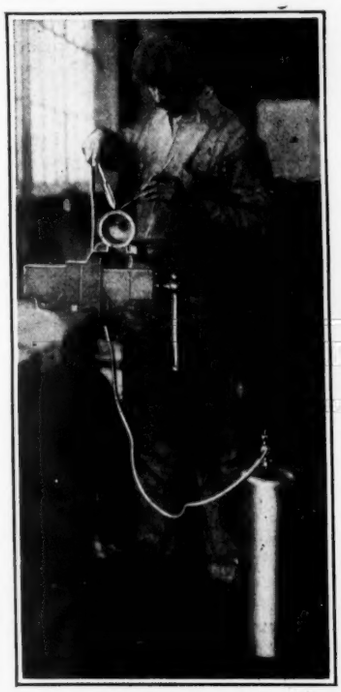
This gear is of the standard Corliss type, identical with that used on steam engines, and consists of a rocker arm which is attached at its lower end to the eccentric reach rod and at its upper end carries a hook and trip. Mounted in the bracket is a shaft which is fitted at one end with a latch and at the other end with the fork that operates the injection valve. As the rocker oscillates back and forth, the hook engages the latch and opens the injection valve, and as the trip controlling the hook comes in contact with an adjustable cam, the hook releases the latch and allows the spring to close the valve. The dashpot on the valve stem assists the spring to start the valve at the beginning of its return stroke and also stops it without shock as it returns to the seat.

The whole mechanism is simple in its operation and easy to adjust. Ample facilities for lubrication are provided at all points where wear is likely to occur. The hook and latch are fitted with removable hardened tool-steel blocks which may be easily turned to provide for eight wearing edges.

Governing is effected by throttling the fuel gas. Under normal operating conditions the injection pressure is around fifteen pounds, but under light load the fuel will be throttled down to seven or eight pounds.

## Blowpipe Handle and Tips for Use with Small Acetylene Gas Tanks

THERE are many industrial heating applications, such as soldering and brazing, where a low flame temperature can be used to advantage. With burners designed for the admixture of atmospheric air, acetylene alone will give a flame hot enough for many purposes. To increase further the adaptability of the small acetylene gas tanks to various uses in the industrial field, the Prest-O-Lite Co., Inc., 30 East 42nd St., New York City, has developed an outfit consisting of a light blowpipe handle and a set of special tips designed to give flames suitable for a wide range of work. The outfit is conveniently used with a small gas tank, the same as is used on a motorcycle or truck, and a 6-ft. length of hose. Acetylene has an advantage over other fuels in that it forms a flame that is non-oxidizing and non-carbonizing and can be readily controlled.



*Soldering iron heated by acetylene flame*

Soldering may be done either with one of the tips, or the blowpipe may be converted into a soldering iron by slipping the soldering copper over the end of the blow-torch tip and tightening a single setscrew. It can be maintained at the right temperature by the internal flame.

# Some Practices in Price Cutting

## A close-up of the present tension between seller and the purchaser that is detrimental to both

By Earl Whitehorne
*Assistant Vice-President, McGraw-Hill Publishing Company*

IN ANY discussion of the evils of price cutting, sooner or later the talk must get down to cases. It is perfectly natural and practical and proper for the purchasing agent to buy as cheaply as he can. And it is no less right for the manufacturer to get as profitable a price as possible. But in the evolution of business certain principles have developed and certain responsibilities. The seller is supposed to give honest value and the buyer is expected to pay an honest price. Why then is there so much talk right now of trouble between large buyers and sellers?

### Tricks of the Purchaser

There are some manufacturers who have the courage to establish prices and maintain them. Their price is their price and they refuse to dicker. But there are some who lack the courage or the strength. And just so there are some purchasing agents who do not haggle. They ask for bids from suppliers whose product is acceptable and the low man gets the business. But there are others who seem to consider their function one of dollar squeezing; and the length to which this gentle art is carried is astonishing. By way of illustration let's just consider a few examples:

*Case 1*—One very large company has a purchasing agent who seems to have complete control of the engineering department and his method is as follows:

The engineers confer with salesmen of various manufacturers and after getting the needed information, issue specifications giving the amounts of apparatus desired, item by item. These are then turned over to the purchasing department and bids called for.

The bids, when received, go to the engineering department, are tabulated and analyzed. They are then handed to the purchasing department with the recommendations as to what the engineers would like. These engineers know what they want, but are required by the purchasing agent to give the names of at least three manufacturers whose apparatus would be acceptable—although the engineers from an operating standpoint, would probably know definitely that one particular type of apparatus or one particular manufacturer would give the best results.

The purchasing agent then notifies the various bidders to appear at his office on a certain date and the result is a flock of salesmen, the majority of whom never had a chance but do not know it, as their names are not included in the engineers' recommendations.

The purchasing agent then retires to a large conference room and calls in his group of engineers—sometimes as many as thirty. One by one the salesmen, those who have a chance and those who never had, are stood up before this imposing group. It is like a man at the bar facing a judge and jury. The purchasing agent, an imposing individual, then holds up a bid asking the trembling salesman if it is his. Admitting the charge, the purchasing agent barks out, "Is this your lowest bid? You have one chance to cut the price."

> INDUSTRY needs more intelligent buying. It needs purchasing agents who know the values of the equipment they buy, and make of their function something more than an adroit matching of prices.
>
> Industry needs more sincerity in selling. It needs manufacturers who consider that a bid is a word given. A bid from a responsible concern to a reputable customer should be a firm bid, the pledge of the house. Firm bids preclude price cutting. They possess every advantage in competition. They maintain price levels by natural processes.

And so the bidding goes, until the harassed salesmen paint, by telephone or telegraph, to their main offices, a story of the battle as they see it. Usually, the story is utter defeat unless the price is reduced.

In a few hours each is called in to report again and is given another last chance and somebody weakens. Then, after all this, the three representatives of the manufacturers selected by the engineers are again called in one by one. They are then given another chance to cut the price—so one by one they are worn down and one of the three eventually weakens.

When the next negotiation comes up, it is usually awarded to some one other than the first successful bidder—and this goes on year after year.

*Case 2*—A practice more or less common in a large company is to issue calls for bids on a certain specification. After all the proposals are in, the purchasing department tabulates them and, calling in the bidders one by one, each is told or led to believe they are a little high in price. Finally, one decides to meet or better the lowest bid submitted. All are in a roundabout way given an idea as to the amount of the lowest bid, told to get in touch with their factories and sharpen their pencils.

As a result, one or more of the manufacturers "bite" and come in with a still lower bid to "get in," as the salesman often says. This is especially true of someone who considers himself an outsider or has never been successful in securing business from this particular buyer.

When the purchasing agent has interviewed the entire list and held them on "hooks" for a time, all the bidders are notified that the specifications have been changed by the engineers and new bids will be called for.

Practically all the time and expense of the first bids are thus lost and the merry-go-round starts all over again. Each one having spent considerable money by this time, some decide to go after the business hard in the hope of saving something out of the wreck. The net result is a free-for-all fight, but the business usually goes to the manufacturer the purchasing agent has had in mind all the time—at a lower price.

Some purchasing agents insist on a lump sum price on all major apparatus required on a job. There are few companies in this country that are in a position to offer such a complete bid. The smaller or specialized manufacturers are at a disadvantage when the engineers favor their equipment for a certain portion of the work, but the purchasing agents insist on a lump sum bid.

In order to obtain the lowest price, the purchasing agent will often ask the the larger companies the amount of reduction they will make in case a certain item is eliminated from the lump sum bid. In order to protect their lump sum bid the larger companies' deduction will naturally be less than it should be when in straight competition.

The smaller manufacturers who cannot bid on the entire specification, but who may have equipment more suitable for the work desired by the engineers, are advised by the purchasing agent that they can have a certain portion of the business by taking it at a figure *equal* to the larger companies' deduction on that item from the lump sum bid.

By this method the smaller manufacturers are therefore offered the business at a price very much under the normal price, and if one of them takes it he is likely to lose money. On the other hand, if refused the business the purchasing agent will tell him that he was high in price and the business went to one company on a lump sum basis.

### Typical Situations

The number and variety of these cases are without end, but there stand out certain typical situations:

1. Where the purchasing agent gets the high bidder to cut on the indefinite promise of a large block of business next year.

2. Where the buyer lies, giving a bidder the false intimation as to his competitor's price, or representing the competing price on motors alone, for instance, as the complete price for motors and control, or citing a price on equipment that is not comparable, or ringing some other subtle change on the truth that deceives and tempts the manufacturer to cut.

3. Where the large buyer demands special discounts for large volume, claiming that this volume carries the manufacturer's overhead, and thus forces the big manufacturer's price down to where the small manufacturer cannot compete.

4. Where large buyers of equipment that is used as part of a manufactured product threaten to make their own motor or control, or whatever it is, unless the price is cut.

5. Where large utility holding companies argue that one of the savings possible through holding company operation should show up as savings in purchasing, and demand discounts over prices given to operating companies.

6. Where purchasing agents apparently do not know how to buy because they have no facts to check bids with and no methods of evaluating bids and therefore resort to haggling.

### What the Seller Does

That's what they are saying about the purchasing agent—not all, of course, but many. But what is the matter with the manufacturer, that he should submit to all this unsound and unfair treatment? The manufacturer right now finds himself in a buyer's market. He is embarrassed in many fields by overcapacity and over-production. He has permitted himself to become involved in a mad scramble for orders.

Some purchasing agents say that the manufacturers are themselves the greatest culprits and are responsible for price buying. They say that first bids today are made for trading purposes only and that the bidders come to them before the ink is dry and offer to cut the prices.

The small manufacturer also charges that, although the large manufacturers state that they desire competition and see no virtue in monopoly, yet they chafe under the competition of the small manufacturer and cut prices to get business, relying on price cutting and not on better quality, better delivery, or better salesmanship to maintain their position. It is alleged that the spread of prices established by these larger manufacturers is unreasonably wide and is not justified by the savings effected in making and selling the larger quantity to the large buyer.

### Tricks of the Manufacturer

1. The large manufacturer uses the lump sum bid as a lever to lower prices on individual products to compete with the small producer who specializes in that line.

2. Allowances are made on old equipment taken back that range all the way from a reasonable scrap allowance to the full original price.

3. Some manufacturers are making extravagant contributions in preliminary engineering expense for detailed working data that is out of all reason and constitutes a price consideration because it puts an undue extra burden on the profit.

4. Financial affiliations between some manufacturers and the utility companies are used in bringing pressure from on high to throw the order.

5. Reciprocity arrangements are drawn into competitive bids to an extent that overshadows the actual comparative values involved and works an injustice upon bidders who are invited to compete with the assumption that it is to be a fair and open contest.

6. And then there are the every-day conditions of price cutting where the manufacturer loses his nerve and pares his price for no other purpose than to get the order.

> THE purchasing agent is charged with profiteering by ingenious methods of beating down price levels. The manufacturer is accused of price cowardice. The result has been demoralizing in many lines.
>
> But men will dicker. Therefore it is recommended that secrecy be eliminated wherever bidders are called upon to reduce a price after bids are in, and that the salesman should demand a showdown and not accept the mere statement that he is high.

Everybody will agree that it is considered wrong to slip your hand into a man's coat pocket and extract his wallet while his attention is distracted. No purchasing agent will do this to a salesman. No manufacturer will do it to a buyer. Well, the only difference is that dickering with bids and cutting prices has not yet lost its social standing. Today it involves no conspicuous degree of moral turpitude. But gradually it is going to be ostracized. The day will come when between intelligent business men price cutting will be taboo.

And it is a matter of simple inescapable truth that destructive commercial warfare between competitors or between buyers and sellers eventually demoralizes markets, wrecks the economic health of the industry, and ultimately paralyzes the service upon which the public is dependent.

### Two Objectives

The greatest single problem in this whole situation is the difficulty of shaking men loose from the purely negative idea that because these unintelligent buying practices are general and have existed for long, they can't be changed. Fundamentally, it seems there are two things to be done:

*One — By the purchaser* — Industry needs more intelligent buying. It needs purchasing agents who know the values of the equipment they buy and make of their function something more than an adroit matching of prices. It needs frank, open recognition of the fact that what is bought must be paid for and that bids which embrace elements of engineering, and of service as well as the delivered product, cannot be compared by a mere tallying of the total cost figures. Therefore, the time must come —will come—when the purchasing agent no longer shall be rated for his penny-squeezing ability, but for his engineering skill in sensing and securing the greatest values for the money spent.

*And Two—By the manufacturer*—Industry needs more sincerity in selling. It needs manufacturers who consider that a bid is a word given—an honest offer of service to a friend—and not just a gesture in a sparring match. In other words, a bid from a responsible concern to a reputable customer should be a firm bid, the pledge of the house, signed with its good name.

All this will not happen at once, but industry can work toward it. And the logical approach to it is for the seller to refuse longer to cut his price because the buyer tells him to. Let him at least begin to protect himself by making sure that the other bids that he is asked to beat are comparable and that the purchasing agent is not lying. If he is asked to refigure after the bids are in, let him at least demand that all the bids be opened to inspection. And also, it is time the manufacturer knew a little more about the reasons why he loses orders, through regularly organized post-mortem studies of the bids.

## Water-Power Resources and Development in Canada

WITH the installation during the past year of new water-power equipment of more than 221,000 hp. there is now installed for all purposes a total of 4,777,921 hp. in Canada. With the completion of work now under way this figure will be increased to more than 5,100,000 hp. before the end of 1928. These new installations, details of which appear in Bulletin No. 1143 recently issued by the Dominion Water-Power and Reclamation Service, Ottawa, are not confined to a particular section of the country but extend from coast to coast. A large proportion of the power installed will be available for public use through the medium of central electric station organizations.

While complete data regarding Canada's water power resources are not yet available, a great quantity of reasonably accurate and much specific data have been collected. All existing stream flow and power data available from federal, provincial and private sources have been systematically collated, analyzed and coordinated with a view to presenting a dependable estimate of available power based on uniform methods of computation and arrangement.

### Estimated Total Resources

During the past year a re-analysis of the power possibilities in various districts has resulted in an increase in the total estimated available figures for the Dominion in spite of the fact that a recent judgment of the Privy Council takes from Canada a considerable area of northeastern Quebec in which large water powers are located. The most recent figures for the Dominion indicate the total resources to be 20,197,000 hp. under conditions of ordinary minimum flow and 33,113,000 hp. ordinarily available for six months of the year. These figures are, of course, subject to revision as more is learned of the flow characteristics and physical conditions of the streams throughout the country.

It is believed that these are conservative estimates, since an analysis of the water-power plants concerning which complete data are available as to turbine installation and satisfactory informtion as to stream flow, gives an average machine installation 30 per cent greater than the ordinary six-months flow power. Applying this, the figures herein quoted, therefore, indicate that the present recorded water-power resources of the Dominion will permit of a turbine installation of approximately 43,000,000 horsepower.

The total installation to date in water-wheels throughout the Dominion is 4,777,921 hp. In other words, the present turbine installation represents only a little over 11 per cent of the recorded water-power resources. Of this, 3,904,678 hp., or 81.7 per cent, is installed in central electric stations for general distribution for domestic, municipal and commercial lighting and power purposes. There is 528,731 hp. or 11.1 per cent, installed in the power plants of pulp and paper mills. In addition the pulp and paper industry purchases some 774,000 hp. from central stations. There is 344,512 hp. or 7.2 per cent of the total, installed for other industrial use.

### Estimated Capital Investment

The capital invested in the water-power industry in Canada is estimated to be $875,000,000, or more than that for any other single manufacturing industry. The corresponding figure in 1910 was $121,000,000, so that the increase in seventeen years is over 600 per cent. This total includes the cost of the primary and auxiliary power plants, transmission and distribution systems with land, machinery and equipment. Applied to the existing installation it amounts to an average of $183 per horsepower. That new capital is readily available for enterprises of a promising character, is shown by the remarkable development carried out within the last three years involving expenditures upwards of $180,000,000.

## New Voltage Regulator Will Increase Carrying Capacity of System

A NEW system of voltage regulation of synchronous apparatus, which will make possible a significant increase in the power-carrying capacity of transmission systems, as well as in the power output for which generators of given physical dimensions may be designed, was announced by C. A. Nickle, of the General Electric Company, in a paper presented before the St. Louis convention of the A.I.E.E. on March 8. The regulator will make it possible to operate alternators and synchronous motors somewhat beyond the static stability limit, hitherto the maximum point at which such equipment could be kept from dropping out of step. The results expected are the possibility of designing for increased ratings of machines of a given physical size and the practicability of transmitting power over a greater distance than is at present economically possible.

### Tests on Miniature Set-Up

The results of tests on a miniature set-up in the factory were presented in the paper. In these tests the power transfer between two similar synchronous machines connected to the same bus was increased about fourfold by the use of the new regulator, over that obtainable under hand controlled steady state conditions. When these same machines were separated by an artificial 500-mile transmission line, the increase in power transfer above the steady state value, obtainable by the use of the new regulator, was approximately 25 per cent and was equal to about 90 per cent of the maximum theoretical power transfer over the line with an infinite bus at each end.

In principle this regulator permits the synchronous machine to operate in what is known as the condition of dynamic stability, in a power range hitherto unexplored because it lay beyond the limit of steady state stability. The condition of dynamic stability may be illustrated by the analogy of a bicycle rider, who depends for his balance upon the restoring forces initiated by his tendency to fall either to one side or the other.

### Regulator Equipment

The new regulator consists in general of a controlled system of generator excitation, operated automatically by relays controlled by the generator terminal voltage. This system is similar to the usual scheme of voltage regulation, but with the additional novel characteristic of extremely sensitive and timely response to changes in terminal voltage. The rotor of the synchronous machine thus regulated oscillates slightly about the dynamic stability point, being kept from dropping out of step by the restoring force of the field current controlled by the regulator.

The increased demand for power and the necessity for developing it in large quantities and transmitting it over long distances, have brought engineers to devote much attention to the study of stability limits, one result of which has been the development of the new regulator.

## Employer's Liability for Injuries to Minor Employees

By Leo T. Parker

GENERALLY, an employer is not liable in a greater degree for injuries sustained by minors than where adults are injured, provided the employer has previously obtained the consent of minor's parent to perform the work.

However, if after obtaining the parent's consent and without again consulting the parents, the employer places the minor at a more dangerous task, the employer automatically becomes liable as an insurer against injuries to the employee, unless it can be proved to the satisfaction of the court that the minor's parents knew their child had accepted more dangerous employment. Under the latter circumstances the courts imply the consent of the parents for the child employee to perform the more dangerous work.

When employing a minor, it is necessary for an employer to obtain consent of the father only. If the father is dead or separated from the mother who has custody of the child, consent of the mother is sufficient.

# NEWS *of the* FIELD

## Norris Muscle Shoals Resolution Passes Senate by 48-25

### Plan Calls for Experimentation in Fertilizers Through Funds from Sales of Power—Nitrate Production in Time of War—Advocates of Government Ownership See Great Victory Ahead

By a vote of 48 to 25 the Senate March 13 adopted the Norris joint resolution providing for federal operation of the government's $150,000,000 plant at Muscle Shoals.

Under the resolution, the money derived from the sale of hydro-electric power would be used for experimentation in the manufacture of fertilizers in time of peace, and the plant operated for nitrate production in time of war.

Amendment after amendment was rejected by the Senate, the most important being the "Underwood" plan submitted by Senator Harrison of Mississippi, proposing a fifty-year lease to private interests with the stipulation that 40,000 tons of fertilizer must be produced annually. This was defeated by a vote of 48 to 26.

Senator Sackett of Kentucky presented a plan to lease the plant to private interests. He said his amendment was identical with the Norris scheme except in the main issue of private versus government operating. This amendment was voted down with a loud chorus of "nays" on a viva voce vote.

#### Believes Issue Not Decided

There has been a seven-year fight to dispose of Muscle Shoals one way or another, but House members interested in the matter do not believe the Senate vote has decided the issue. It is freely said that the House will not agree to government operation as recommended by Senator Norris of Nebraska, the Progressive Republican.

The House Military Committee has just completed hearings in private session on the Willis-Madden bill, which in effect recommends that Muscle Shoals be turned over to the American Cynamid Company for fertilizer manufacture. Public hearings will now be held on other bills.

Advocates of government ownership are acclaiming the passage as a great victory for the principles for which they stand. If the House can be influenced to follow the example of the Senate, they see the beginning of the Tennessee Hydro-Electric Commission, modeled along the lines of the Ontario Commission. At the beginning of the debate Senator Norris frankly announced that one of the purposes of his resolution is to demonstrate the advantages of government operation of power plants.

#### Commission to Regulate Rates

Not only does the government enter into the business of generating and selling power, with preferences to municipalities and farmers' organizations, but the resolution passed by the Senate sets up the Federal Power Commission as the agency to regulate the rates to be paid for this power within the states.

It also is recognized that the passage of the Norris resolution greatly strengthens the hand of the supporters of the Swing-Johnson Boulder Canyon bill. The Senate's endorsement of government operation at Muscle Shoals also is regarded as paving the way for a similar effort on the St. Lawrence and on other streams where large power resources are available.

#### Hope of Opponents in House

The hope of those who are opposed to government in business is that the House, which has become the conservative branch of Congress, may insist upon the elimination of the government operation feature of the resolution. The requirement to operate plant No. 2 also will be opposed strenuously in the House. Some are of the opinion that the effort on the part of the government to operate that type of plant, which many regard as obsolete, is foredoomed to failure and is likely to result in a reaction against any use of Muscle Shoals for fertilizer production.

## Midwest Power Conference Plans European Tour

A large number of engineers associated in the Midwest Power Conference are planning to go abroad on an international power tour. The party will sail from New York City Aug. 18. Most of the large power plants and new developments in the various countries will be visited.

The tour will last six weeks; and in conjunction with the visits to the plants, several sightseeing and pleasure jaunts have been arranged.

Foreign engineering bodies have extended the warmest of invitations to the American engineers. Stations will be thrown open for their inspection and receptions will be given for them at several points on the tour route.

Headquarters for the tour have been established by the Midwest Power Conference at Suite 656, 25 Broadway, New York City.

## Accident at Westinghouse Not Due to Turbine Explosion

Contrary to newspaper statement, the fatal accident which occurred March 13 in the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company was due not to the explosion of a turbine, but to the failure of part of the temporary shop equipment for testing.

The accident happened during the heater box run on the low-pressure spindle of a large turbine, stated H. T. Herr, vice-president of the Westinghouse company.

During the shop tests of a large spindle temporary equipment is required to permit the overspeed run in a special casing installed in the erecting shop. A coupling adapter plate, which is a part of this equipment used only in shop tests, burst during the test and broke the coupling housing into fragments. This is the first accident resulting in serious injury since the opening of the South Philadelphia plant ten years ago.

## Gallery of A.S.M.E. Past Presidents for Cooper Union

The collection of framed photographs of past presidents of the American Society of Mechanical Engineers, dating back to 1880, and long housed in the Council room of the Society's national headquarters in the Engineering Building, 29 West 39th St., New York City, was formally turned over to Cooper Union at the recent annual dinner of the Union alumni.

The portraits, forty-five in number, portray leaders in the progress of American science and invention, and in industry and education. Engineers, college professors, scientists, financiers, and industrialists, past and present, are represented in what was described as an "engineering hall of fame."

## A.I.E.E. Plans for Regional Meeting at Baltimore

Of much interest to power engineers will be the Middle Eastern district regional meeting of the American Institute of Electrical Engineers, which will take place at the Hotel Belvedere, Baltimore, April 17-20. An excellent program has been prepared for the technical sessions, and a number of inspection trips planned.

Papers will include the subjects of dielectric and power generation, one session of four contributions treating of dielectrics and insulation. Studies will be presented covering the design of the Gould Street Generating Station of the Consolidated Gas, Electric Light & Power Company; and others will deal with the Conowingo development of the Philadelphia Electric Company, covering such features as the general design of the project, the 220-kv. transmission lines, quick-response excitation and stability calculations.

### Papers to Be Presented

One of the principal features will be a lecture Tuesday evening, April 17, by Dr. R. W. Wood, professor of experimental physics at the Johns Hopkins University, speaking on "Sounds That Burn."

On Wednesday afternoon there will be an inspection trip to the Gould Street Station, and on Friday an all-day tour of the Conowingo development, where a luncheon will be provided by the Philadelphia Electric Company.

With Dr. J. B. Whitehead, dean of the Engineering School of Hopkins, presiding, the first session held the afternoon of April 17 will include "Developments in the Insulation of Coils for High-Voltage Turbo-Generators," by C. H. Hill, Westinghouse Electric & Manufacturing Company, and "Drying and Evacuating of Impregnated Paper Insulation," by J. B. Whitehead, W. B. Kouwenhover, F. Hamburger, Jr., Johns Hopkins University.

### Study and Inspection of Conowingo to Conclude Meeting

On Wednesday morning, W. S. Gorsuch presiding, A. S. Loizeaux, Consolidated, Gas, Electric Light & Power Company, will read a paper on "The Gould Street Generating Station," and a study of designs for that plant will be contributed by F. T. Leilich, C. L. Follmer, R. C. Dannettel, of the Baltimore utility. "Operating Experiences" will be told by A. L. Penniman and F. W. Quarles, also of that company.

Alex. Wilson, 3rd, Philadelphia Electric Company, will offer "The Conowingo Hydro-Electric Development on the Susquehanna" at the morning session of April 19, and R. A. Hentz will speak on "Electrical Features of the Conowingo Generating Station and the Receiving Substations at Philadelphia." P. H. Chase will give the concluding paper of the session, describing "The 220-Kv. Transmission Lines for the Conowingo Development." In the afternoon "Super-Excitation for the Synchronous Condensers for the Conowingo System" will be the subject of D. M. Jones, General Electric Company. Inspection will be made of that development Friday morning.

## Recent Applications for Power Projects

The Roanoke River Power Company, Richmond, Va., has applied to the Federal Power Commission for a license covering a project on Roanoke River near Briggs Island. It is proposed to construct a dam 80 ft. high to create a reservoir with 240,000 acre-feet capacity. The reservoir would extend upstream for 23 miles. It is planned to install 70,200 hp. and to construct a transmission line to connect with the system of the Appalachian Power Company. The primary capacity of the project is 8,900 horsepower.

A license covering a project on Flint River, Ga., proposed to install four units of 3,600 hp. each for power for general public use, has been applied for by J. J. Williams, O. M. Heard, W. E. Grubbs, P. F. Fitzgibbons and Dr. J. A. Ward of Cordele, Ga.

John L. Fish, of Lakeside, Ariz., has applied for a license covering a project on Salt River, Gila County, Ariz. It is proposed to install 24,000 hp. capacity.

The City of San Point, Idaho, has applied for a preliminary permit covering a site on Priest River, in Bonner County, Idaho. It is proposed to construct four dams and power houses. The installed capacity proposed is 10,000 horsepower.

## British Standardize Power Switchboards

The standardization of electric power switchboards for indoor installations up to and including 33,000 volts for direct-current circuits and for alternating circuits up to and including a frequency of 100 cycles per second is dealt with in a new British specification.

The general clauses include definitions and details of design and construction which are common to switchboards for all voltages, and provide for the arrangement of busbars, connections and wiring, interchangeability between component parts of similar design and rating, protection of operator, protection against fire, safety devices, interlocks, indicating devices and coloring of signal lamps and remote control.

Other sections deal with the requirements, additional to those in the general clauses, for low and medium voltage and for high and extra high voltage installations respectively, the latter comprising both cellular and metal-inclosed types. The specification has been prepared by the British Engineering Standards Association.

## Electric-Steam Generator Realizes Large Economy

Savings of $6,000 in a heating season of eight months, or a return of 6 per cent on an investment of $100,000, are estimated by the Central Maine Power Company as the result of the installation of an electric-steam generator for heating its own and some private buildings.

This company operates a steam-electric generating plant at Lewiston, Me., and hydro-electric power is also available at that point from its plant at Gulf Island, Me. At Lewiston it is necessary to keep the steam plant warm, as well as to heat the office building and storehouse. In addition, the company furnishes heat by contract to a local theater and a hotel.

Previous to the installation of the electric-steam generator, heat was supplied by a section of the oil-burning boilers. The electric-steam generator now in use utilizes surplus hydro-electric power generated at the Gulf Island plant. The steam boiler, built by the International Engineering Works, is 66 in. in diameter, 19 ft. in over-all length, containing 72 steel tubes 3 in. in diameter, by 16 ft. long and is built for a working pressure of 125 lb.

### Claims Nearly 100 Per Cent Boiler Efficiency

The complete electrical equipment was furnished by the General Electric Company and consists of 144 heating units, four control panels and four pressure governors, and is equipped with a Copes water regulator, making the operation entirely automatic. The boiler is designed for 440-volt three-phase operation and has a connected capacity of 1,200 kw., divided into four circuits of 300 kw. each. An automatic control panel and pressure governor are provided for each 300-kw. circuit, the pressure governors being set a few pounds apart so that the sections will be thrown on and off successively with falling or rising of steam pressure.

The efficiency of the boiler, as estimated by the owner, is almost 100 per cent, as all of the energy is expended inside the boiler and in such a case, if the boiler is well insulated, the loss from radiation is practically negligible. Power consumption is from 14,000 to 16,000 kw.-hr. for 24 hours on an average winter day. The power company considers the power consumed by the boiler as surplus, as it would otherwise be wasted over the dam.

## Boulder Dam Amendment Rejected by Senate

An amendment to the Swing-Johnson Boulder Canyon Dam bill proposed by Senator Ashurst, Democrat, of Arizona, and providing for the distribution of waters, was rejected March 13 by the Senate Irrigation Committee, by a vote of 9 to 3.

## Throttle Valve Blows Off—Kills 2 on River Steamer

When a steam throttle valve blew off in the engine room of the "Senator Cordill," an Ohio River steamer undergoing repairs at Point Pleasant, W. Va., March 2, two men were instantly killed, one of them the chief engineer, George McElhose, and another probably fatally injured.

A federal steamboat inspector had visited the steamer only a few hours previous to the explosion and pronounced the boiler and steam pipes in good condition. Captain George Beegle, master of the steamer, was in the engine room and attempted to shut off the main valve. He was badly scalded.

The "Senator Cordill" had been fitted up with a new battery of boilers by the Acme Boiler Works, of Gallipolis, Ohio, and was then taken to Point Pleasant for new piping, installed by the Heslop Machine Shop. The inspection was made when the piping was tested by a pressure much heavier than necessary for the operation of the engines. When the accident occurred the pressure was about 125 lb. The steamer, the largest packet boat on the upper Ohio River, was practically ready to make its first run of the season to Pittsburgh. It is owned by the Shippers Line, of Pittsburgh.

## Iowa Railway & Light Plans Cedar River Project

The Iowa Railway & Light Corporation, Cedar Rapids, Iowa, has filed application for permission to erect and operate a hydro-electric power plant on the Cedar River, near Rochester, Cedar County, Iowa. The proposed plant will cost $2,000,000 and develop 23,000,000 kw.-hr. annually to supply power plants in eastern Iowa.

Isaac B. Smith, president of the corporation, has announced that the construction will not be undertaken for three years, or until present power units prove inadequate for local demands. A lake covering approximately 2,250 acres will be created with the concrete wall 22 ft. above the permanent crest of the normal level of the lake, with a spillway parallel to the river channel to protect the dam against flood conditions.

Five hydro-electric units of 1,400 kva. each are to be installed, connected by vertical shafts to the hydraulic turbines, which are to be of vertical type.

## Stevens Institute Welcomes Dr. Davis at Dinner

In honor of Dr. Harvey Nathaniel Davis, of Harvard University, whose selection as president of Stevens Institute of Technology, Hoboken, N. J., to succeed the late Dr. Alexander C. Humphreys was announced last week, the board of trustees of the institute gave a dinner of welcome at the Hotel Astor, New York City, March 15.

More than 500 members of the board faculty, alumni and friends of the school were present to greet Doctor Davis. Walter Kidde, acting chairman of the board, presided. Dr. Frank L. Sevenoak, who has served as acting president since Doctor Humphrey's retirement in June, introduced the president-elect, who delivered an address. Franklin B. Kirkbride, of the board of trustees, also spoke.

At the reception in connection with the dinner, Doctor and Mrs. Davis met the alumni of the institute by classes, representatives of some of the earliest classes in the 70's being present.

## Wins A.S.M.E. Student Prize for Kinematics Paper

For his study on "The Kinematics of Quick Return Mechanisms," Ferdinand Singer, a graduate of the College of Engineering of New York University, received the prize given by the Metropolitan Section of the American Society of Mechanical Engineers for the best paper contributed by a student in 1927, it was announced March 14 at the Metropolitan Student Branch convention, meeting at the Engineers' Building, New York City.

More than 500 delegates were present from various colleges and universities in this section, including Columbia University, City College, Rutgers University, Cooper Union, Pratt Institute, New York University, Newark Institute of Technology, Stevens Institute of Technology, and Brooklyn Polytechnic Institute.

## Addresses Iowa N.A.P.E.

The Ottumwa, Iowa, chapter of the National Association of Power Engineers was addressed by Fred Stocker, chief engineer of the local plant of the Iowa Southern Utilities Company at its latest meeting upon "Construction and Operation of Steam Turbines."

## Burden of Corporation Income Tax Not on Consumer

The federal corporation income tax cannot be shifted to the consumer and it does not affect prices nor the movement of capital investment, excepting under unusual circumstances, as during war times or possibly in the case of corporations enjoying patent, monopolistic or similar advantages.

The burden of the corporation income tax in the case of all corporations exposed to fully effective competition lies on the investor or shareholder, who pays the tax directly or indirectly because it reduces profits and hence tends to reduce dividends or surplus.

These are the conclusions of the National Industrial Conference Board, 247 Park Avenue, New York, after an exhaustive research investigation undertaken at the request of the Joint Congressional Committee on Internal Revenue Taxation, a preliminary summary of which will shortly be submitted to the committee.

## Bureau of Commerce Expands Through Six New Offices

Among the developments of the Bureau of Foreign and Domestic Commerce, Department of Commerce, made possible by added appropriations for the next fiscal year, will be the establishment of six new district offices. These branches are to be located in Denver, Indianapolis, Birmingham, Pittsburgh, Milwaukee, and one in the State of North Carolina.

The Commerce Department already maintains 23 district offices and 34 cooperative offices in this country. The object of these offices is to render immediate service to nearby business men. The records of the Department show that during the last fiscal year these offices performed over 2,000,000 commercial services.

# *Personal Mention*

FRANK G. COX has resigned as second vice-president of the Edge Moor Iron Company, and is now with the Otis Elevator Company, New York City.

DR. D. S. JACOBUS, advisory engineer to the Babcock & Wilcox Company, New York City, accompanied by Mrs. Jacobus, is spending some weeks at Stuart, Florida.

PROF. WILLIAM J. DANA, of the mechanical engineering department of North Carolina State College, was chosen president of the Raleigh Engineers Club at its annual election meeting March 6.

A. C. WRIGHT, mechanical engineer in charge of construction for the Eastern Oregon Light & Power Company, has moved his headquarters and his home from Baker to La Grande, Ore., where he is occupying a suite of three offices in the West-Jacobson building.

HENRY A. SUPRENANT, for six years superintendent at the Vernon station of the New England Power System, has been promoted to superintendent of operation covering the Western Division with headquarters at Shelburne Falls. He has been succeeded at Vernon by Fred W. Clough.

I. E. MOULTROP, chief engineer of the Edison Illuminating Company of Boston, will sail for Europe March 31 for three or four months of inspection and study of power problems. While in Holland, Mr. Moultrop will attend

as a representative of the United States National Committee the Advisory Committee on Steam Turbines of the International Electrotechnical Commission, meeting May 20-26.

ROBERT T. HASLAM, formerly professor of chemical engineering at the Massachusetts Institute of Technology in charge of courses in gas and fuel engineering, recently became associated with the Standard Oil Development Company, a subsidiary organization of the Standard Oil Company of New Jersey, as manager of the development department.

## *Society Affairs*

AMERICAN WATER WORKS ASSOCIATION, Florida Section will hold its second annual meeting at the San Juan Hotel, Orlando, April 3-4; E. L. Filby, secretary, P. O. Box 135, Jacksonville, Fla.

AMERICAN WATER WORKS ASSOCIATION, Illinois Section, will hold its 20th annual meeting March 29-30, at the University of Illinois, Urbana. M. L. Enger, professor of mechanics and hydraulics, University of Illinois, is secretary.

A.S.M.E.—Engineers' Club of San Francisco, March 29, 7 p.m. Subject: "The Design of Steam Electric Generating Stations," by R. C. Powell, assistant chief of division of electric distribution and steam, Pacific Gas & Electric Company, of San Francisco.

A.S.M.E.—Philadelphia — Engineers' Club of Philadelphia, 1317 Spruce St., Philadelphia, March 27; dinner at 6 p.m. Meeting at 8 p.m. Subjects: "Progress in the Burning of Coal," by Prof. A. G. Christie, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md. "Special and Anti-Knock Fuels," by Dr. Graham Edgar, director of research, Ethyl Gasoline Corporation, New York; "Recent Developments in Low Temperature Carbonization," by Col. H. D. Savage, president of the Dry Quenching Equipment Corporation, New York.

A.S.M.E., DETROIT SECTION in joint meeting with the DETROIT ENGINEERING SOCIETY, evening of March 21, will be addressed by Alex Dow, president of The Detroit Edison Company and the A.S.M.E., speaking on "Anticipating the Electric Power Requirements of a Metropolitan District."

A.S.M.E., CLEVELAND SECTION, Cleveland Engineering Society Rooms, 7:30 p.m. April 2, symposium on the "Progress and Status of Engineering Standardization in Cleveland." George T. Trundle, consulting engineer will be the principal speaker. Col. E. C. Peck will be chairman of this meeting.

## Coming Conventions

**American Association of Engineers,** annual convention, El Paso, Texas, June 4-6; M. E. McIver, secretary, 63 Adams St., Chicago.

**American Institute of Electrical Engineers,** Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

**American Institute of Refrigeration,** Washington, D. C., May 10-11.

**American Refractories Institute,** annual meeting at White Sulphur Springs, W. Va., May 8-9; Dorothy A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh.

**American Society of Refrigerating Engineers,** meeting at Detroit, June 4-7; W. H. Ross, secretary, 37 West 39th St., New York City.

**American Society of Heating and Ventilating Engineers,** Summer meeting at West Baden Springs Hotel, West Baden, Ind., June 26-29; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

**American Society of Mechanical Engineers,** spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City; Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3.

**American Society for Testing Materials,** Atlantic City, June 25-29.

**American Water Works Association.** Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

**Association of Iron and Steel Electrical Engineers,** annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

**Indiana Fuel Conference** at Purdue University, Lafayette, Ind., April 5-6.

**National Association of Power Engineers,** annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

**National Board of Boiler and Pressure Vessel Inspectors,** meeting at Erie, Pa., June 18-20.

**National Electric Light Association,** Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

**National District Heating Association,** annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

**Stoker Manufacturers Association,** fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

**Universal Craftsmen Council of Engineers,** Newark, N. J., Aug. 7-10.

**Second Bituminous Coal Conference** will be held at Pittsburgh, Nov. 19-22.

## *Business Notes*

THE NATIONAL CARBON COMPANY, INC., moved its New York factory from its former location at 357 West 36th St., New York City, to new and larger quarters at the company's plant at Fourteenth and Henderson Sts., Jersey City, N. J., March 15.

THE GENERAL ELECTRIC COMPANY has announced that Robert W. Adams, manager for the company's sales office for Rhode Island and eastern Connecticut, is now in charge of the central station department for the New England district. For many years Mr. Adams has taken an active interest in the Prov-

## *Fuel Prices*

### COAL

**The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:**

| **Bituminous** (Net Tons) | Market Quoting | |
|---|---|---|
| Navy Standard... | New York..... | $2.40@$2.65 |
| Kanawha..... | Columbus..... | 125. @ 1.60 |
| Smokeless..... | Cincinnati..... | 2.25 |
| Smokeless..... | Chicago..... | 1.75@ 2.25 |
| S. E. Kentucky... | Chicago..... | 1.35@ 1.75 |
| Steam..... | Pittsburgh..... | 1.60 |
| Gas Slack..... | Pittsburgh..... | 1.05 |
| Big Seam..... | Birmingham.... | 1.50@ 2.00 |
| **Anthracite** (Gross Tons) | | |
| Buckwheat..... | New York..... | $2.75@$3.25 |
| Birdseye..... | New York..... | 1.60 |

### FUEL OIL

**New York**—Mar. 15, industrial use, tank-car lots, 28@34 deg., Baumé, 4½@5c. per gal.; 36@40 deg., 5½@6c. per gal., f.o.b. Bayonne, N. J.

**St. Louis**—Mar. 6, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 30@32 deg., $1.75 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5.15c. per gal.

**Pittsburgh**—Feb. 21, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

**Philadelphia**—Mar. 14, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26@$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@30 deg., $2.10@$2.16 per bbl.

**Cincinnati**—Mar. 13, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

**Chicago**—Mar. 9, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., 90@95c. per bbl.; 30@32 deg., $1.10 per bbl.

**Boston**—Mar. 12, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@32 deg., 5¾c. per gal.

**Dallas**—Mar. 9, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

idence (R. I.) Engineering Society, of which he was acting president in 1917 and president in 1918. He is a member of the A.I.E.E.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY recently announced a new motor starter with a maximum rating of 7½ hp. The addition of this new line starter now provides a complete line of full-voltage starting devices ranging from 1 to 75 hp.

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, announces the appointment of R. T. Stafford, formerly district manager of the Seattle office, as assistant manager of the electrical department in charge of sales and engineering at the Pittsburgh Transformer Works. John Alberts, of the Seattle office, has been appointed district manager, succeeding Mr. Stafford. The Seattle district embraces the States of Washington and Oregon, having a branch office at Portland.

## *Trade Catalogs*

BUILDING HEATING—"Correct Heating of Buildings," a booklet published by Webster Talmadge & Co., Inc., shows the advantage of using central control for zoned heating systems equipped with high resistance radiators.

THE TAYLOR UNIT—The American Engineering Company, Philadelphia, has issued a very attractive bulletin describing the Taylor unit in a series of six artistic sketches, accompanied by a comprehensive but brief explanation of the action illustrated.

GATE AND GLOBE VALVES—The Wellman-Seaver-Morgan Company, Cleveland, in bulletin No. 89 treats of Wellman Supertes gate and globe valves designed for high pressures and temperatures in steam plants, oil refineries, pipe lines, hydraulic, air, gas, chemical service and other industrial purposes. Many figures illustrate the text.

PUMPS—The new water filtration plant of the City of Wenatchee, Wash., is described in a paper by Fred J. Sharkey, city engineer, and S. De Moss, structural engineer, which has been reprinted and is being distributed by the De Laval Steam Turbine Company, Trenton, N. J., builders of the pumping equipment. Water is taken from the Columbia River, which is subject to considerable fluctuations in level at this point, through an intake pier and is conducted to an electrically operated pumping plant and sedimentation basins and filters located on the river bank.

SAVING FUEL—The Farnsworth Company, heat reclamation engineers, Conshohocken, Pa., describe and illustrate systems and steam specialties featured by the company. Of special interest are the drainage receiver and pump semi-balanced, single seat valves, low pressure or high pressure super-feed water heaters, and tilting types of drainage receiver and pump and drainage receiver and boiler feeder.

CROSS DRUM BOILERS—The Edge Moor Iron Company, Edge Moor, Del., in catalog No. 65, just printed, presents in interesting and easy-to-read form the principal facts concerning the Edge Moor cross drum boiler. Many photographs, illustrating both design and construction, and the comparatively small amount of text tell the story completely and briefly. The latter part of the booklet, reproduced by special permission of the Boiler Code Committee of the American Society of Mechanical Engineers, will be of practical value to operating engineers.

# NEW PLANT CONSTRUCTION

**California**—Utica Mining Co., 1300 Balfour Bldg., San Francisco, plans the construction of a power plant, total fall 527 ft. maximum amount of water through penstocks to be 55 cu.ft. per sec., total amount of power to be developed 3,294 hp., also dam 70 ft. high, 430 ft. long on top, 50 ft. on bottom, 10 ft. wide on top in Tuolumne and Alpine counties. Estimated cost $150,000.

**Calif., Sacramento**—Financial Building Corp., G. C. Sellon, is having plans prepared for a 10 story office building at 7th and J Sts. Estimated cost $1,400,000. G. C. Sellon Co., California Life Bldg., is architect.

**Calif., San Diego**—Balboa Hotel Corp. is having plans prepared for a 16 story hotel and stores building on A. St. here. Estimated cost $1,000,000. A. W. Stevenson, Spreckels Bldg., San Diego, and Trayer and Jacobs, 1008 West 6th St., Los Angeles, are architects.

**Calif., Santa Cruz**—City plans an election to vote $125,000 bonds for the construction of a hydro-electric plant in San Lorenzo Valley section. Estimated cost $125,000. R. Fowler, is city engineer.

**Calif., Watsonville**—Apple Growers Cold Storage Co., c/o Uttley & Kleindinst, 354 Hobart St., Oakland, Engrs., will build a 300 x 500 ft. cold storage plant on Beach Rd. here. Estimated cost $250,000. Work will be done by separate contracts.

**Colo., Lamar**—Southern Colorado Power Co., c/o W. N. Clark, Gen. Mgr., Pueblo, plans to remodel electric generating plant, also plans a transmission line between Lamar and Las Animas.

**Conn., Montville**—Robert Gair Co., 420 Lexington Ave., New York, N. Y., awarded contract for the construction of a boiler house to Berlin Construction Co., Berlin. Estimated cost $40,000.

**Ill., Chicago**—Illinois Club for Women, 814 South Michigan Ave., is having plans prepared for a 26 story hotel including swimming pool, etc. at Rush and Ontario Sts. Estimated cost $3,000,000. Holabird & Roche, 104 South Michigan Ave., are architects.

**Ill., Chicago** — Syndicate, c/o A. S. Alschuler, 28 East Jackson Blvd., Archt., is having sketches made for a 25 story apartment building on East 50th St. and East End Ave. Estimated cost $1,650,000.

**Ind., Anderson**—Indiana General Service Co., Muncie, plans the construction of a sub-station. Estimated cost $50,000.

**Ia., Cedar Rapids**—Iowa Railway & Light Corp., I. B. Smith, Pres., 201 2nd Ave., has made application for permission to construct a hydro electric plant and dam on the Cedar River near Rochester to generate 9,500 hp. Estimated cost approximately $2,000,000.

**Kan., Wichita**—Wichita Municipal University, plans the construction of a heating plant. Estimated cost $50,000. E. Forshblom, Sedgwick Bldg., is architect.

**La., Baton Rouge**—City plans an election Apr. 10 to vote $180,000 bonds for the construction of a pumping station along edge of University Lake from Menard to river in connection with sewage treatment work.

**La., New Orleans**—Commercial Hotel Co., Maison Blanche Bldg., is receiving bids for an 18 story hotel including steam heating system, elevators, etc. on Common St. Jones, Roessle & Olschner, Maison Blanche Bldg., are architects.

**Md., Baltimore**—Bethlehem Shipbuilding Corp., will receive bids until Mar. 21 for the construction of an office building including 40 x 80 ft. power house on Key Highway. Estimated cost $150,000. Private plans.

**Mass., Boston**—Penal Institutions Dept., will receive bids until Mar. 21 for the construction of a power house on Deer Island, Boston Harbor. J. H. Ritchie & Associates, 250 Stuart St., Boston, are architects.

**Mass., Danvers** — Commonwealth of Massachusetts, South Essex Sewage, Fort Ave., Salem, will soon award contract for the construction of a pumping station at ft. of Doty Ave.

**Mass., Lynn**—Lynn Gas & Electric Co., E. B. Frazer, 90 Exchange St., will soon award contract for the superstructure of a boiler house on Broad St. Estimated cost $225,000. Stone & Webster Inc., 49 Federal St., Boston, are architects.

**Mass., Pittsfield**—Chamber of Commerce, American Hotels, plans the construction of a hotel. Estimated cost $1,500,000. Lockwood Greene & Co., 24 Federal St., Boston, are architects.

**Mass., Winchester**—Arlington Gas Light Co., 689 Massachusetts Ave., Arlington, will receive bids until Mar. 24 for the construction of a heater and governor house here. Estimated cost $25,000.

**Mich., Detroit**—The Cul-Lan Co., 1601 Storh Bldg., Archt., is preparing plans for a 10 story apartment building including steam heating and refrigeration systems, boilers, elevators, etc. on North Woodward St. Estimated cost $1,250,000. Owner's name withheld.

**Mich., Detroit**—Weston & Ellington, 1507 Stroh Bldg., Archts., will receive bids about Apr. 1, for the construction of a home including steam heating and ventilation systems, boilers, elevators, etc. at Southfield and Six Mile Rd. for Little Sisters of Poor, Scott and Orleans Sts. Estimated cost $700,000.

**Mich., Detroit**—Donaldson & Meier, 1335 Penobscot Bldg., Archts., are receiving bids for a 35 story office building including steam heating and ventilation systems, boilers, etc., at State and Griswald Sts. for Stott Realty Co., 409 Lincoln Bldg.

**Mich., Mt. Clemens**—S. Norton Price, 87 North Ave., is having plans prepared for an 12 story office building including steam heating system, elevators, etc. Weston & Ellington, 1507 Stroh Bldg., are architects.

**Mich., Morley**—Consumers Power Co., 244 West Michigan Ave., Jackson, is having plans prepared for the construction of a dam 1000 ft. long for hydro-electric plant to develop 35,000 hp. here. Private plans.

**Mich., Muskegon**—West Michigan Sand & Fuel Co., 8th and West Clay St., awarded contract for the design and construction of a marine loading dock including conveyors, hoppers, elevators, etc. to Robert Love Construction Co., National Bank Bldg. Estimated cost $200,000.

**Mo., Anglum**—B. F. Mahoney Co., San Diego, Calif., will build a factory including power house and central heating plant here. Estimated cost $50,000. Work will be done by separate contracts.

**Mo., Kansas City**—Scottish Rite Temple, c/o E. R. Jones, 5800 State Line, is having plans prepared for a masonic temple at Linwood and Paseo Sts. Estimated cost $1,500,000. Keene & Simpson, 1005 Land Bank Bldg., are architects.

**Mo., Marshall**—City plans an election to vote $80,000 bonds for extensions and improvements to light plant. Henrici-Lowry Engineering Co., 402 Security Bldg., Kansas City, Mo., is engineer.

**Mo., St. Louis**—Bd. of Public Service, L. Day, Comr., City Hall, awarded contract for addition to waterworks pumping station at City Sanitarium, Arsenal St. and Brannon Ave. Estimated cost $148,000.

**Mo., St. Louis**—T. Rollhaus, 606 Central National Bank Bldg., Archt., is preparing plans for an 8 story apartment building including steam heating, and electric refrigeration systems, elevators, etc. Estimated cost $650,000. Owner's name withheld.

**Neb., Harvard**—City voted $40,000 bonds for the construction of an electric light plant.

**N. J., Belleville**—Bd. of Chosen Freeholders, E. L. Smith, Supt., Soho St., is having plans prepared for a 4 story addition to hospital including steam heating and ventilation systems, boilers, etc. Estimated cost $1,000,000. Sutton, Sutton & Calkins, 402 Broad St., Newark, are architects.

**N. J., East Orange**—Bd. of City Council, City Hall, awarded contract for the construction of a city hall on North Arlington Ave. to Frank Briscoe Co., 810 Broad St., Newark. Estimated cost $1,500,000. Steam heating system, etc. will be installed.

**N. J., Newark** — Eight Hundred Fifty Broad St. Corp., C. Eisler, Pres., c/o N. Harris, 20 Branford Pl., is having sketches made for a 17 story office building including steam heating system, etc. at Broad and Lafayette Sts. Estimated cost $1,000,000.

**N. J., Newark**—Twenty Six-Thirty Two Johnson Ave. Inc., c/o Berwyn Estates, M. E. Harris, 384 East 37th St., Paterson, had plans prepared for a 10 story apartment including steam heating and refrigeration systems, boilers, elevators, etc. Estimated cost $500,000. H. F. Clark, 38 Clinton St., is architect.

**N. Y., Albany** — St. Peters Hospital, J. Gibbons, Albany Diocese, will soon award contract for a 9 story hospital at New Scotland Ave. Estimated cost $1,000,000. Robert & Reilly, 10 East 41st St., New York, are architects.

**N. Y., Binghamton** — Rymerback System, awarded contract for the construction of a hotel and garage to Thompson Starrett Co., 250 Park Ave., New York. Estimated cost $2,500,000.

**N. Y., Brooklyn** — Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the construction of a refrigeration plant, here.

**N. Y., New York**—A. P. Hess, 345 Madison Ave., Archt., is receiving bids for a 9 story apartment building at 427 East 51st St. for Middleton Estates, Inc., c/o architect. Estimated cost $1,000,000.

**N. Y., New York**—Jatison Construction Co. Inc., A. Tishman, Pres., 285 Madison Ave., had plans prepared for an 11 story apartment building at 1040 Lexington Ave. Estimated cost $900,000. Schwartz & Gross, 347 5th Ave., are architects.

**N. Y., New York**—Schultz & Weaver, 17 East 49th St., Archts., will receive bids about Apr. 5, for the construction of a hotel at 499-515 Lexington Ave. Estimated cost $2,800,000. C. R. Place, 420 Lexington Ave., is engineer.

**N. Y., New York** — New York Athletic Club, W. Kennelly, Pres., 56 Central Park South, had plans prepared for a 26 story hotel. Estimated cost $2,000,000. R. T. Lyons, 40 East 49th St., is architect.

**N. Y., New York**—Rayback Holding Co. Inc., 65 West 47th St., had plans prepared for a 15 story apartment at 11 West 106th St. and Central Park W. Estimated cost $1,000,000. W. L. Rouse, 512 5th Ave., is architect.

**N. Y., New York**—Tudor City Seventh Unit, E. Monroe, Pres., 350 Madison Ave., had plans prepared for a 32 story hotel at 312 East 42nd St. Estimated cost $2,500,000. F. F. French Co., 350 Madison Ave., is architect.

**N. Y., Rochester**—Seneca Athletic Club, 724 Mercantile Bldg., is having sketches made for a 7 story club building at Goodman and East Ave. Estimated cost $1,000,000. Gordon & Kaelber, 311 Alexander St., are architects.

**N. C., Henderson**—City will soon receive bids for the construction of a raw water pumping station, dam, etc. W. C. Olsen Inc., Raleigh Building & Loan Bldg., Raleigh, is engineer.

**N. C., Marion**—Western Carolina Power Co., Charlotte, plans the construction of a sub-station here, also a power line from Marion to Rutherfordton a distance of 25 mi.

**N. C., Winston-Salem**—Reynolds Tobacco Co. awarded contract for a 21 story office building at Fourth and Main Sts., to J. Baird & Co., Inc., 441 Lexington Ave., New York, N. Y. Estimated cost $1,900,000.

**Okla., Oklahoma City** — Harbour-Longmire Co., 418 West Main St., will soon award contract for an 8 story stores building including steam heating, ventilation and refrigeration systems, elevators, etc. on Main St. Estimated cost $600,000. Hank & Parr, are architects.

**Tex., Fairfield** — Community Power & Light Co., D. S. Caldwell, Gen. Mgr., Mexia, will build a 10 ton ice and cold storage plant here. Private plans.

**Tex., Galveston** — W. L. Moody, Jr. & Associates, will soon award contract for an 11 story hotel including steam heating and ventilation systems, boilers, elevators, etc. Estimated cost $1,000,000. A. Fraser, 624 American National Insurance Bldg., is architect.

**Tex., Jacksboro** — T. G. Shaw, Holmes Bldg., Fort Worth, has been granted franchise for the construction of a gas distribution system and booster pumping unit. Estimated cost $35,000. Private plans.

**Tex., San Angelo**—Hilton Hotel Co., c/o W. R. Irwin, Secy., awarded contract for a 12 story hotel at Oakes and Twohig Sts. to D. D. Hall. Estimated cost $1,000,000.

**Tex., San Antonio** — Interstate Amusement Co., K. Hoblitzelle, Dallas, plans the construction of a 10 story theatre and office building including steam heating system, etc. at Houston St. between St. Marys and Navarro Sts. Estimated cost $2,500,000. J. Eberson, 200 West 57th St., New York, is architect.

**Wash., Seattle**—Baker Vogel & Rousch, L. C. Smith Bldg., Archts., will receive bids about June 1, for a 12 story club building including swimming pool, etc. at 6th and University Sts. for Washington Athletic Club, c/o architect. Estimated cost $1,000,000.

**Wis., Milwaukee** — Milwaukee Electric Railway & Light Co., 217 Michigan St., will build a 70 x 90 ft. addition to power plant. Private plans.

**Ont., Hamilton** — Syndicate, c/o W. H. Yates Construction Co., 17 Main St. E., is having plans prepared for a 10 story hotel including steam heating system, elevators, etc. at Main and Hughson Sts. Estimated cost $1,000,000. Hutton & Sauter, 6 James St. S., are architects.

**Ont., Toronto**—Syndicate, c/o Kirk Hyslop, and R. Dennis 43 Adelaide St. W., Archts., is having plans prepared for an 18 story office building including steam heating system, elevators, etc. at Bay and Albert Sts. Estimated cost $1,000,000.

## Equipment Wanted

**Blowers, Stokers, Etc.**—Canadian Pacific Ry. Co., Montreal, Que., E. N. Bender, Gen. Purch. Agt., plans to purchase Diamond soot blowers and mechanical stokers for Glen Yard power house.

**Boilers, Engines, Generators, Etc.**—Hawley Pulp & Paper Co., W. P. Hawley, Oregon City, Ore., plans to purchase central steam high pressure boilers, engines and generators, electrically driven, for pulp and paper plant to be rebuilt. Estimated cost $3,000,000.

**Boilers, Pumps, Etc.**—Indianapolis Water Co., Indianapolis, Ind., plans to purchase two new boilers for Riverside pumping station, also electrical driven pumps at filter plant, etc. Estimated total cost $600,000.

**Condenser**—Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, Ont., plans the installation of a synchronous condenser for proposed power transmission lines from Trent River power plants to Port Hope and from Port Hope to Oshawa. Estimated cost $365,000.

**Electrical Equipment**—Port of New York Authority, 75 West Street, New York, N. Y., will receive bids until Mar. 26, for electrical equipment for Elizabeth-Howland Hook bridge over the Arthur Kill between New Jersey and Staten Island.

**Engine and Generator**—City of Beaver, Okla., plans to purchase a 200 hp. Diesel engine and generator for electric light plant.

**Engine, Pumps, Etc.** — Mount Vernon Laundry, Mount Vernon, Ill., plans to purchase a 20 hp. steam engine, also boiler feed pumps.

**Loading and Unloading Equipment** — Ralston-Purina Co., G. W. Haynes, Supt., 3831 Hiawatha Ave., Minneapolis, Minn., plans to purchase loading and unloading equipment for proposed grain storage tanks. Estimated cost $250,000.

**Pump**—Borough of Coraopolis, Pa., W. E. Cain, 1018 5th Ave., Secy., will receive bids until Apr. 2 for a 1,500,000 g.p.d. triplex plunger pump.

**Pump**—Town of Pembroke, Ont., plans the installation of a 1400 g.p.m. centrifugal pump, probably electric driven.

**Pump**—City of Seward, Okla., plans to purchase a deep well pump for proposed waterworks system. Estimated cost $15,000.

**Pump, Conveyor, Transformers, Etc.**—R. Hall, Clk., Anderson, Ind., will receive bids until Mar. 26, for a 15 m.g.p.d. motor driven pump, elevator conveyor, four transformers, etc. for proposed 15,000 v. sub-station.

**Pump, Etc.**—Western Public Service Co., C. Ely, Supt., Alvin, Tex., is receiving bids for a 500 g.p.m. direct connected pump, 3 ph., 2200 v., etc. for proposed waterworks improvements. Estimated cost $25,000.

**Pump and Motor**—City of Depew, Okla., plans to purchase a deep well pump and motor for proposed waterworks improvements. Estimated cost $17,000.

**Pump and Motor**—City of St. Louis, Okla., plans to purchase a deep well pump and motor, etc. for proposed waterworks improvements. Estimated cost $30,000.

**Pump, Water Wheel, Etc.**—City of Burlington, N. C., E. B. Horner, Mayor, will receive bids until Apr. 2 for one 2,000 g.p.m. centrifugal pump, one 250 hp. water wheel, etc.

**Pumps**—City of Rush Springs, Okla., plans to purchase triplex pumps, etc. for proposed waterworks improvements. Estimated cost $30,000.

**Pumps**—City of Columbia, Ill., will receive bids until Mar. 26 for one 250 g.p.m. motor driven and one 250 g.p.m. gasoline driven centrifugal pumps, etc. for proposed waterworks improvements. Estimated cost $28,000.

**Pumps**—City of Marlin, Tex., will soon receive bids for pumps, etc. for proposed sewage disposal plant. Estimated cost $38,000.

**Pumps**—City Council, P. A. Coker, Clk., Brookhaven, Miss., will receive bids until Apr. 3 for two 750 g.p.m. non-clogging centrifugal sewage pumps against a total head of 15 ft. with motors, controls, etc.

**Pumps, Etc.**—Borough Council, Blawnox, Pa., will receive bids until Apr. 6, for pumps, etc. for proposed sewage treatment work.

**Pumps, Etc.**—Town of Glencoe, Ont., will soon receive bids for pumps, etc. for proposed waterworks system. Estimated cost $70,000.

**Pumps, Motors, Etc.**—Sewer Improvement District No. 1, L. A. Black, Chn., De Witt, Ark., will receive bids until Mar. 27 for two 4 in. vertical pumps, two 5 hp. motors with necessary equipment, etc. for proposed sewage treatment plant.

**Pumps and Motors**—United States Shipping Board, Dept. of Maintenance & Repair, 45 Broadway, New York, N. Y., will receive bids until Mar. 28 for 66 pumps and eight motors for eight ships to be converted to Diesel drives, types of pumps, salt water cooling and general service, fresh water piston cooling, lubricating oil, etc.

**Ropes, Governor, Spring Bumpers, Etc.**—Fayette Tile & Trust Bldg., S. A. Elleard, Ch. Engr., Uniontown, Pa., in the market for 4 new elevator cabs, controllers, ropes, governors, spring bumpers and other accessories for 110 v. d.c. 250 f.p.m. passenger elevators.